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An Educated Democracy

AMONG the social services which have undergone remarkable developments in Great Britain during the present century is that of education, and particularly of secondary education since the passing of the Education Act of 1902. The actual and potential changes in the structure of society brought about by these expansions of educational opportunity are far-reaching, yet it may be doubted whether their significance is generally appreciated. This is the view of Mr. G. A. N. Lowndes, who in a recent work with an arresting title* says: "Nothing is more exasperating to those to whom social reform is religion in action than the readiness with which the English neglect, forget or minimize their achievements." Mr. Lowndes recalls and appraises those achievements in the field of public education, elementary, secondary and technical, in the past forty years, thanks to which Great Britain, it is claimed, is becoming "an educated democracy". Some of the most telling in the series of contrasts through which the magnitude of these achievements is presented illustrate the progress of secondary education—progress which has been rightly characterized as 'revolutionary' by statesmen and historians.

The secondary school population has quadrupled and now includes 350,000 former pupils of public elementary schools. In 1934 the proportion of elementary school pupils, aged 10–11, passing into secondary schools was 119 per thousand, whilst in 1895 the corresponding proportion (elementary school leavers passing on to endowed grammar schools) was probably not more than 3–6 per thousand. Forty years ago the number of pupils holding county and county borough scholarships at schools of secondary type was 2,414, as compared with the 224,981 total, and 23,188 partial, exemptions from payment of fees in grant-aided secondary schools in 1934.

These figures indicate an appreciable advance towards that elusive goal—equal educational opportunity for equal abilities. A similar advance is discernible when one turns to statistics of the output from the grant-aided secondary schools to the universities. Of the 4,192 students who passed from those schools to universities in 1934 (London 1,040, Wales 613, Cambridge 463, Oxford 382, other universities 1,694), 1,983 of the men and 831 of the women had begun their education in elementary schools; 2,209 had paid no fees. Comparable statistics of forty years ago are not given, but Mr. Lowndes recalls a reply given by a witness examined by the Cross Enquiry Commission in 1888 to a question as to the prospects of a public elementary school pupil ever reaching a university: "It would be next to expecting a boy out of the London Board Schools to take wings . . .", and adds "He was right."

The output from the grant-aided secondary schools to the universities has been a subject of comment in the Board of Education's reports since 1924, when in the course of a comprehensive review of secondary education attention was directed to the rapid increase of this output between 1909 and 1921 from 1,056 to 2,888, chiefly ex-public elementary school pupils. The following year the Board remarked: "It is commonly assumed that a secondary school provides an avenue to the university, at any rate for able pupils. Fifteen years ago this assumption was

* P. 236 of "The Silent Social Revolution: an Account of the Expansion of Public Education in England and Wales, 1895–1935". By G. A. N. Lowndes. Pp. xii+274+8 plates. (London: Oxford University Press, 1937.) 6s. net.

not generally warranted." In 1909–10 about 400 out of 950 schools on the grant list sent one or more pupils to the university. By 1924 there were very few that did not at least occasionally send one. In 1932 the output to the universities had increased to 4,560 and since then the numbers have declined, the total in 1935–36 being 3,578.

The position in regard to assisted students in the universities was reviewed by the University Grants Committee in the last quinquennial report (for 1929–30 to 1934–35). The Committee emphasizes the extent to which the approach to the universities is made possible by scholarships, maintenance allowances, or eleemosynary grants. At least £1,350,000 is spent in this way annually by Government departments, local education authorities, universities, Oxford and Cambridge colleges and the trustees of public endowments in Great Britain. The Committee adds that fifty per cent of the students in the provincial universities began their education in public elementary schools. In further illustration of the same point may be cited, from the Board of Education's report for 1935–36, the fact that out of 719 open scholarships at Oxford and Cambridge 374 were won by pupils at the grant-aided secondary schools, of whom nearly three fourths had paid no fees and two thirds had been previously educated in public elementary schools.

The contribution of the grant-aided secondary schools to the universities is really greater than that represented by the Board's statistics already mentioned, because these exclude the considerable number of students who enter universities after an interval instead of proceeding immediately from school. The number so excluded was estimated by the Board in 1925 to have been about ten per cent; according to Mr. Lowndes, twenty per cent is nearer the mark. Assuming the intake of the universities from this source to be between four and five thousand, how does this compare with the intake from other sources? The total of admissions into the universities of England and Wales is about twelve thousand, of whom about ten per cent are from outside the British Isles. Whence come the remainder, from six to seven thousand, who do not come from the grant-earning secondary schools? With very few exceptions, from the other secondary schools. The grant-aided schools account, according to an estimate in the University Grants Committee's report, for five sixths of the whole secondary school population. The estimate is perhaps a high one, but it seems plain that more than a moiety of the influx of students is from a comparatively small catchment area.

This state of affairs is, of course, associated with that dual system of which Lord Baldwin declared in 1929 "the interests of social unity demand the removal of this source of class prejudice", but which seems immune to the equalitarian influences of the "silent social revolution". Its most obnoxious feature is that, as the authors of "In Defence of Democracy" (Methuen, 1935) put it, it operates to make the consciousness of social difference all pervasive in the working of men's minds in all social and political questions. The success of Rendcombe College goes to show, however, according to Mr. J. H. Nicholson ("Education for Modern Needs": Ivor Nicholson and Watson, 1936) that this feature can be eliminated from the "public schools". Certainly any tendency to divide the community into mutually unintelligible groups is specially to be deplored at a time when a maximum of social unity is needed for meeting the challenge involved in the rise of the powerful and energetic totalitarian régimes.

To that challenge Mr. Lowndes's book makes no reference; nor have the achievements he tells of contributed conspicuously towards generating that active vigorous citizenship in harmony with democratic principles which is indispensable for their maintenance. The sectional loyalties fostered in so many of our schools are not enough, and wider views will have to be taken if education is to provide a firm basis for constructive democracy.

During the past four years, much valuable work in this direction has been done by the Association for Education in Citizenship, of which Lord Baldwin has recently accepted the presidency. It seeks "the best methods of educating citizens who are likely to maintain and strengthen our democratic system". Much promising exploratory work has been done in various schools (see the Association's "Experiments in Practical Training for Citizenship"), but it has to be recognized that any training for citizenship before the age of fourteen or fifteen years, when the great majority of citizens of the future leave school, can be but very elementary. The British genius for self-government was evolved in the hard and efficient school of learning by doing in days when every village householder had to do his bit of community service, and training in citizenship for the million must await the acceptance by the nation once again of the burden of national service for all.

Frazer on Totemism

Totemica:
a Supplement to "Totemism and Exogamy". By Sir James George Frazer. Pp. xii+518. (London: Macmillan and Co., Ltd., 1937.) 25*s.* net.

HALF a century ago, in 1887, there appeared in Edinburgh a small booklet entitled "Totemism". It was destined to exercise an influence on the science of man second only to that of another masterpiece by the same author—I mean of course Frazer's "Golden Bough". Both works produced an immediate impression at home among scholars and abroad among workers in the field. Both have since reappeared in a much fuller form; the first as "Totemism and Exogamy" (in four volumes, 1910); the second as a series of twelve volumes jointly named "The Golden Bough" (1911–15).

Each of the two great works has now received a valuable epilogue: "Aftermath", a supplement to "The Golden Bough", published last year; and now "Totemica", giving the finishing touch to Frazer's work on totemism. To those of us who owe the main inspiration of our life-work to Frazer these recent events are both welcome and significant. The additional volumes bear witness not only to the vigour and creative power of the author but also to the value and vitality of the British school of anthropology.

Frazer, more than anyone else, has given the science of man wide currency among cultured people all over the world. It is largely due to the literary charm of his style and the profoundness of his insight that anthropological books are now extensively read, appreciated, and enjoyed. He also, above all others, has brought anthropology into line with classical scholarship. Nor is it an accident that the first systematic and planned scientific expedition was undertaken from Cambridge, Frazer's spiritual home and personal abode. The work of Spencer and Gillen in Central Australia, the researches of Roscoe among the Baganda, the African classics of Smith and Dale, of Rattray, and of Junod, throughout bear witness to Frazer's genius and vision.

The direct imprint of Frazer's ideas on anthropological theory is not less remarkable. Take the range of its subject-matter: magic and kinship, social organization and the clan system, political power and problems of early science, of ritual and religion: in all these Frazer has given at least the initiative and in most cases the fullest and most adequate treatment of each subject. When the great Frenchman, Durkheim, was shaping his theory of primitive religion, he had in "The Golden Bough" an encyclopædia of fact upon which to draw, and a compendium of theoretical points of view to inspire him. When Freud made his attempt to apply psycho-analysis to the 'cave man' and his murderous and incestuous offspring, he turned to Frazer's "Totemism and Exogamy" and to "The Golden Bough". Most modern schools of anthropology, whether 'functionalism' or 'structuralism', the search for 'patterns of culture' or hunt for 'tribal geniuses', largely depend for their inspiration on Frazer.

The present book is a review of evidence on totemism which has accumulated since 1910. It is arranged geographically, pride of place being naturally given to Australia: ". . . for it is to Australia, with its varied and very primitive forms of Totemism, that we must ultimately look, if we are ever to find a clue to the problem of the origin and meaning of the institution" (from the preface). From that continent some new and important facts have been brought to light in field-work organized from Sydney by Prof. A. R. Radcliffe-Brown and his successor Dr. A. P. Elkin. Some of the discoveries, such as those by R. Piddington and P. M. Kaberry, W. E. H. Stanner and U. McConnel shed a new light on our theoretical conception of totemism.

Readers of Frazer, that is, all anthropologists, will note with interest that the new evidence establishes the widespread occurrence of two facts: the ignorance of physical paternity and the magical ceremonies for increasing totemic species. It is on these two ethnographic facts that Frazer founded his hypotheses of the origins of totemism.

Equally rich and interesting is the evidence from Oceania. It has been known since the times of Codrington that developed forms as well as the rudiments of totemism are to be found in Melanesia. Its occurrence among the Polynesians, foreshadowed by Rivers, has since been established through the recent researches of Drs. R. W. Firth and H. I. Hogbin. The data from Africa and India which Frazer is able to register in the present book, important as they are, do not add anything revolutionary to our knowledge. America, the continent in which totemism was discovered, has yielded only twelve pages.

Frazer himself keeps aloof in this book from controversy; nor does he work out his earlier theories any further. It is tempting, therefore, to inquire how far these have been strengthened or modified by recent discoveries and developments

in anthropological doctrine. In his first theory, dating back to the original book of 1887, Frazer finds the origins of totemism in the widespread belief in the external soul, a belief in which primitive man associates his welfare and destiny with some symbolic object. Organized on a communal scale, that is, associating a whole clan with an animal or plant species, this belief becomes in substance totemism.

Frazer himself has discarded this view as a theory of the origins of totemism. We cannot, however, dismiss it as a contribution towards the understanding of the primitive tendency to symbolize, nor yet of the constitution of primitive society. An external symbol seems to be indispensable in the integration of primitive, and for that matter even of civilized, groups. Durkheim, developing Frazer's theories more fully, has rightly insisted on the functional value of the Australian *churinga* and of our modern flag, of the medieval scutcheon, and the crown and sceptre of contemporary monarchs. The appreciation of social symbolism, of the concept of the external soul in its wider setting, reveals to us some of the workings of the primitive, that is, essentially human mind, and of group integration at all levels of development. For the progress of civilization in a way consists in the imprint of things spiritual being given to matter, while shaped matter fashions spiritual processes in turn. The very essence of symbolism in thought, in speech and writing, in liturgy and in art is, after all, nothing else but the concept of 'external soul' developed and refined beyond recognition and yet without any breach of continuity. Thus Frazer's first hypothesis can be regarded as the starting-point of some of the most important developments in the study of culture.

The second theory, formulated by Frazer after the sensational discoveries of Spencer and Gillen in Australia, links up totemism directly with magic. The Arunta and allied tribes perform magical ceremonies of totemic increase in which every clan acts as a co-operative unit in a vast enterprise of multiplying edible and otherwise useful animals and plants. The means to this practical end appear to us completely fictitious. This, however, does not detract from their social and even educational value. They bring home to the participants the importance of co-operation, the necessity of obeying rules and following tribal tradition—an aspect of ceremonial life brought out by Prof. Radcliffe-Brown in the second part of his "Andaman Islanders".

The role of magic as an all-important organizing and integrating force can be seen even more clearly at a level higher than that of the Australian and Andaman islander. In the Trobriand Islands the garden magician, in virtue of his mystical power over Nature, becomes the leader and organizer of the enterprise: he acts as the agricultural expert and supervisor of work (*cf.* "Coral Gardens" by the reviewer). So also the man who magically controls wind and weather, the dangers of the open seas, and the vicissitudes of the commercial moods of his trading partners, acts as captain of the canoe and master of an overseas expedition ("Argonauts of the Western Pacific"). As regards Polynesia, the connexion between magic and practical activities has been well documented by Dr. R. W. Firth in his "Primitive Economics of the New Zealand Maori" (1929).

In his third and final theory of totemic origins Frazer reveals the significance of the primitive ignorance of physiological paternity. Here once more the Central Australians provide the cue. They believe that conception is due to the entry into a woman's womb of a totemic spirit-child. These are believed to reside in sacred spots, primarily deposits of bull-roarers (*churinga*), where mythical ancestors, half-human, half-totemic, had left their souls and their magical implements. This belief, argues Frazer, is sufficient to explain the reason why primitive man regarded himself as mystically bound up with an animal, plant, or inanimate object. It accounts also for the formation of clan bonds, and it explains why, through his totemic kinship with natural phenomena, primitive man claimed magical control over natural processes and objects.

At the time when Frazer was setting forth his theory, he was really generalizing boldly—some might even say, too boldly—from evidence confined to one insignificant tribelet in the deserts of Central Australia. Yet here once more Frazer's genius had anticipated the course of future discoveries. Animistic beliefs about conception have since been discovered in one tribe of Australia after another until their distribution map almost covers the continent. They have been signalled by Rivers from Melanesia, by the present reviewer from eastern New Guinea, and by Dr. Hogbin from Polynesia.

It is interesting to note that simultaneously with Frazer's "Totemica" there appears a monograph dealing with totemic paternity in aboriginal Australia. It is really a monument to Frazer's insight and vision, and to the value of his theories of totemism (M. F. Ashley-Montagu, "Coming into Being among the Australian Aborigines" 1937). Dr. Ashley-Montagu concludes that, with very few and insignificant exceptions, "the orthodox doctrine of each tribe" in Australia is "that children are the result of the immigration into a woman of a spirit child which is of an origin going back into the far distant mythological past. . . . Thus it is that by means of this belief

in the immigration of spirit children into women the proper totemic and moiety membership of the child is secured". (*Op. cit.* p. 199.)

Taking any one of the three hypotheses in isolation, it might be contended that none of them alone is sufficient to account for the birth and nature of totemism. Taken in conjunction, they give a full and adequate explanation of the phenomenon. They all centre round the conception, almost the definition, of totemism which runs through Frazer's theoretical treatment and gives the perspective to his magnificent edifice of fact: totemism expresses ritually and mythologically man's selective interest in a number of animal or plant species; it discloses the primitive's profound conviction that he is in body and mind akin to the relevant factors of his environment. These he is able to control magically in virtue of the kinship; and towards them he has to observe a religious attitude of reverence and consideration.

In any theory of totemism, we have first and foremost to account for the linking of man with environmental forces and principles. In his third theory, Frazer makes the important suggestion that the primitive ignorance of reproductive physiology combined with beliefs of spirit-child incarnation is the natural basis of totemic kinship between man and Nature. This bond was to primitive man not merely an intellectual affirmation and a sentimental attitude; it became above all a means of action. Since his interest in his surroundings was pragmatic, that is, nutritive and utilitarian, and his earliest means of control magical, the main function of totemic belief consisted in the ritual of magical increase directed upon useful or practically important factors of the environment. Thus we are led inevitably to Frazer's second hypothesis, in placing the first within the context of primitive thought, feeling, and action.

Such terms and concepts, however, as 'principles of fertility', 'useful environmental factors' go beyond primitive man's intellectual horizon. He has to use concrete and tangible symbols, both ritually and psychologically. The principle of ritual symbolism, that is, the belief in the external soul, on which Frazer lays emphasis in his first theory, is the indispensable corollary to our understanding of the magical function of totemism and of its conceptual origins. The Australian *churinga*, for example, is the prototype of the external soul. In native belief it is also the main reservoir of spirit-children. In the increase ceremonies it becomes the main instrument of magical efficacy. This small object embodies as it were and epitomizes Frazer's hypotheses of totemic origin; and, let us remember, to the Central Australian the *churinga* is the most sacred and important object in the whole universe. It represents to him tradition, magical force, and the social unity of the clan, condensed but all-powerful. It stands for a long line of ancestors; it gives man the means of securing wealth and welfare; it is the source of human fertility. In 'singing' to his *churinga*, in his mythologies and ritual actions, the Central Australian pragmatically bears witness to the intuition and insight of the great historian of totemism.

Frazer's theories explain not only the origins of totemism but also its functions. From the survival point of view, it is vital that man's interest in the practically indispensable species should never abate, that his belief in his capacity to control them should give him strength and endurance in his pursuits and stimulate his observation and knowledge of the habits and nature of animals and plants. Totemism, in the light of Frazer's theory, appears thus as a blessing bestowed by religion on primitive man's efforts in dealing with his useful surroundings, upon his 'struggle for existence'. At the same time it develops his reverence for animals and plants on which he depends, to which he feels in a way grateful, and yet the destruction of which is a necessity to him.

Frazer's interpretation of totemism gives us still the best insight into the earliest phases of religion, of man's pious attitude of dependence, of his early seeking for permanent tangible values instinct with spiritual and moral substance. Within the framework of Frazer's interpretation we see how in totemism the beginnings of ethical attitudes are developed through the magical co-operation of clan members, and of the clans for the welfare of the whole community. Frazer has also shown that totemism, in its insistence on material symbolism, contains perhaps the earliest rudiments of sacred metaphor, that is, of abstraction, with all its possibilities of development into ritual, on one hand, and science on the other.

Frazer's contribution has been as essential to the progress in empirical field-work as to our theoretical understanding of primitive man. More than that, in his great works, "The Golden Bough", "Totemism and Exogamy", "The Fear of the Dead", "The Belief in Immortality" and "Folk-lore in the Old Testament", Frazer has given us in outline a lasting philosophy of culture capable of indefinite development.

The extraordinary sympathy and insight with which the leader of the British school has treated primitive ways of thought and action, his fundamental humanism, his scientific acumen and artistic intuition have allowed him to reveal most of the problems with which modern anthropology is concerned. Frazer's vision has also led him to foresee the main currents of empirical discovery and to lay down the foundations of the comparative science of human cultures.

B. MALINOWSKI.

Hydrocarbons

The Reactions of Pure Hydrocarbons

By Gustav Egloff. (American Chemical Society Monograph Series, No. 73.) Pp. xvii + 897. (New York: Reinhold Publishing Corporation; London: Chapman and Hall, Ltd., 1937.) 84s. net.

FEW men are more widely known or popular at gatherings of petroleum technologists than Gus Egloff, largely on account of his immense knowledge of his subject and his willingness to impart it to others. His research record is also second to none, so that a book from his pen is assured of a ready reception based on the expectation that it will prove to be of outstanding utility and interest.

The teaching of organic chemistry began for most of us with the paraffin hydrocarbons, though as we progressed we took but little interest in their chemistry. It is the conversion of the oil industry into a chemical industry that has brought about their extensive reinvestigation.

Faraday's famous paper in 1825 on "New compounds of carbon and hydrogen obtained during the decomposition of oil by heat" introduced benzene to the world, and already in those days "The Portable Gas Co." prepared gas by decomposing a mixture of fish and vegetable oils. In the latter part of the last century, oil gas was successfully used in lighting railway carriages, being made by the Pintsh process from petroleum or shale oil by heating—what is to-day termed cracking. An early description of this process by H. E. Armstrong (*J. Soc. Chem. Ind.*, Sept. 29, 1884) summarizes what must have been some of the first experiments on the pyrolysis of hydrocarbons.

Of late years, the hydrocarbons have assumed a new aspect, since it has been realized that almost unbelievable quantities are naturally available all over the world, appearing as gases, liquids and solids. The outstanding progress made by the oil industry in marketing liquid products is well known; as a by-product of refining, it produces large volumes of hydrocarbons supplementing the billions of cubic feet of natural gas handled daily. Natural gas in favoured countries has replaced manufactured illuminating gas. A new industry which is growing up is based on using the hydrocarbons, particularly those which are unsaturated, as the raw materials of an ever-increasing variety of chemical syntheses, and by cracking the saturated hydrocarbons an unlimited amount of unsaturated raw material is available.

Egloff divides the hydrocarbons into seven groups, distinguished as paraffins, olefines, acetylenes, aromatics, cyclo-paraffins, cyclo-olefines and terpenes. Although each group is individual in properties, it can be produced from, or converted into, most of the other groups under varying and to a high degree controllable conditions generally involving pyrolysis. Such processes have become of technical importance.

The seven main chapters of the book deal with the reactions of these groups, which are subdivided again under the individual hydrocarbons of the homologous series. Egloff uses the words "pure hydrocarbons" in his title, the justification being that the technique has progressed so far that in most instances complete separation is possible though the hydrocarbons are obtained in complex mixtures.

Theoretically, any organic compound may be prepared from its parent hydrocarbon, so that for the future a cheap source of this parent will give a great impetus to the development of synthetic organic chemicals: this is indeed likely to happen.

Inasmuch as paraffins are more susceptible to thermal than to chemical treatment, chief interest is attached to their decomposition both in the laboratory and in the factory when they are being transformed into more reactive unsaturated hydrocarbons. Hence the importance of an accurate knowledge of their decomposition reactions. The olefines are studied largely from the point of view of their susceptibility to polymerization, rearrangement to isomeric hydrocarbons and decompositions.

Acetylene has characteristic properties due to its unsaturation and high negative heat of formation, which enables it to polymerize into simple or complex molecules, such changes being facilitated by catalysts. Acetylene will be the source of many new substances, such, for example, as duprene (neoprene) the new synthetic rubber material. As yet, the higher acetylene homologues have been but little studied.

The reactions of benzene and its homologues bring the average chemist on familiar ground; here Egloff deals in detail with the theory and mechanism of their pyrolytic reactions.

The naphthenes or cyclo-paraffins have been much less studied though very large quantities are available. The 100 pages of this chapter are full of information not easily available elsewhere: some day these compounds will be put to specialized uses.

The final chapter concerns the terpene hydrocarbons present in the essential oils of plants, whereas the other hydrocarbons described are of mineral origin: there are terpenes in certain mineral oils. The major industry connected with terpenes is that of turpentine and resin. Great

interest attaches to isoprene, the unit hydrocarbon of rubber. Egloff has been at pains to collect the information relating to the thermal decomposition and polymerization of this group.

The magnitude of the work is evidenced by the fact that the subject and author index occupy 44 pages in double column. Its utility is unquestionable, it is veritably a master work, and future workers all over the world will be obligated to its author; indeed it will undoubtedly accelerate the development of the subject experimentally.

E. F. ARMSTRONG.

Agents affecting Plant Growth and Movement

Der Einfluss einer Pflanze auf die Andere, Allelopathie

By Prof. Hans Molisch. Pp. viii + 106. (Jena: Gustav Fischer.) 4.50 gold marks.

IN this book, Prof. Molisch published shortly before his death an interesting account of a number of experiments he carried out to examine the effect exerted by one living plant upon another. His investigations do not deal with the so-called autogenetic radiations of Gurwitsch, of which he is a little sceptical, but have their starting-point in the known fact that, if early and late maturing apples are stored in close proximity, the latter arrive at maturity earlier than if they are stored separately. The same effect has also been observed in the case of pears. As it is known that ethylene is produced in the process of respiration of ripening fruits, it is probable that ethylene vapours are responsible for this phenomenon. Indeed Elmer, Huelin, Gane and other workers of the Food Investigation Board have not only proved the ripening effect of these ethylene-containing vapours of apples and other fruits, but have also shown that they inhibit the sprouting of potatoes and the growth of pea seedlings (see Gane, NATURE, 134, 1008; 1934). Experiments by Crocker in the United States have shown that epinasty of leaves can be induced by ethylene, and E. M. Harvey has determined the effect of ethylene on plant metabolism.

Molisch's experiments were concerned with the growth of seedlings exposed to the natural emanations from maturing apples, pears, oranges, lemons and bananas. Using the seeds of peas and vetches he found that, by placing a few apples in the closed vessel containing the germinating seeds, the growth of the seedlings was considerably retarded. Instead of attaining a height of 12–16 cm. in five days in a water culture, the peas seedlings had only grown 3–4 cm. in height. Grown in sand, the difference was even more striking. A further experiment showed that if the seedlings were exposed to the effect of maturing apples for only 1–5 hours their growth was actually stimulated, their height being 10 cm. when exposed for 1 hour and 9·5 cm. when exposed for 5 hours as compared with 7 cm. in pure air. The gas in dilute concentration evidently acts as a stimulant, agreeing in this respect with certain other organic poisons like morphine and amygdalin. The effect of other maturing fruits was of a similar retarding nature and in addition, as in the case of apples, they produced curious curvatures of the stem.

Epinastic curvatures of the leaves of growing plants, for example, *Solanum* and *Bœhmeria*, were also observed, and in other cases (privet and *Mimosa*) the proximity of apples produced leaf-fall.

The book contains further interesting records of the effect of ripening apples on the growth of roots, on the formation of callus, the development of lenticels, on the growth of pollen tubes and of fungi.

As it is known that roots excrete certain organic acids and also carbon dioxide, Molisch carried out some experiments with the roots of horse radish, carrot and beet and found that they had a slight stimulating effect on the growth of seedlings, but if the roots were cut longitudinally into four pieces they retarded growth. A considerable stimulus to growth was exerted by the root system of *Melaleuca squamea* and *Acacia verticillata*.

The effect of the proximity of vegetative shoots on the growth of vetch seedlings was to retard their elongation to a greater or less extent, while flowering shoots and particularly the flowers themselves inhibited growth in length very markedly. The inflorescences of the lilac had a deleterious effect on the growth of tomato seedlings.

At the end of the book, Molisch discusses the possible importance to the plant of the production of ethylene. Since he had shown that it retards the development of the mycelium and sporangia of *Phycomyces*, he concludes that it may prevent or at any rate delay the rotting of the fruits. On the other hand he is inclined to accept the view of Crocker that it may act as a fruit-ripening hormone. He points out that its action has much in common with such a growth-promoting substance as hetero-auxin. It causes similar epinastic curvatures, it delays the opening of buds and promotes the development of callus in poplar and the production of roots in cuttings of willow.

These undoubted resemblances between ethylene and some of the plant hormones are certainly very suggestive, and it is to be hoped that Molisch's book may lead to further researches in their elucidation.

Naturgeschichte der nordatlantischen Wale und Robben

Von Prof. Dr. Ernst Hentschel. (Handbuch der Seefischerei Nordeuropas, herausgegeben von H. Lübbert und E. Ehrenbaum, Band 3, Heft 1.) Pp. v + 54 + 10 plates. (Stuttgart: E. Schweizerbart'sche Verlagsbuchhandlung (Erwin Nägele), 1937.) 15 gold marks.

THIS is a comparatively small new part of Lübbert and Ehrenbaum's indispensable handbook of the North European fisheries. It is by Dr. Ernst Hentschel, known to us by a useful book on the marine mammals, published twenty-five years ago.

Here we have, in some fifty pages, a brief but sufficient account, well and copiously illustrated, of all the whales, dolphins, seals and walrus which inhabit the North Atlantic region, and have in some cases a wider, even a world-wide, distribution. All the great whales come into the story except the Californian Grey; and even that is said by some to have reached European coasts in former days.

Here and there the book seems to miss something. The herds of Ca'ing whales are mentioned at the Faeroes, but not at the Orkneys, though to them these islands owe their very name; Murie's paper on the same small whale is mentioned, but not his fine monograph on the walrus; the large walrus skull in Fig. 43 looks suspiciously like the Pacific variety; the peculiar teeth of the porpoise, so easily distinguishing it from all the other dolphins, are not mentioned; and the figure of the "gestreifter Delphin", whose "Rücken ist mit einer Anzahl unregelmässiger heller Streifen gezeichnet", merely shows, unless we are greatly mistaken, the scars of a recent encounter with a cuttlefish. D. W. T.

Univers 1937:

quelques aspects de l'astronomie contemporaine. Par Prof. Paul Couderc. Pp. xii + 182 + 12 plates. (Paris: Les Éditions rationalistes, 1937.) 20 francs.

THIS work serves a double purpose. Almost entirely devoid of mathematical formulæ, it is accessible to general readers who are interested in astronomy, though practically ignorant of its most recent developments. Nevertheless, the author has never dealt with any subject in a superficial manner, and it is amazing how he has condensed into such a small space the results of modern research, while still maintaining accuracy and precision in his descriptions. In the work we find all the most up-to-date information on nebulæ, stellar spectra, galactic rotation, proper motions, the expanding universe, the age of the universe, novæ, cosmic clouds, etc. Prof. Couderc has kept very closely in touch with every phase of the subjects, which he handles with consummate skill and with wonderful clarity in his descriptions.

The book is illustrated by ten plates, some of which are due to the first telescope installed at Forcalquier, the future astrophysical station in France. Altogether we have found it a most readable work. M. D.

Astronomy for the Layman

by Frank Reh. Pp. xviii + 308 + 16 plates. (New York and London: D. Appleton-Century Co., Inc., 1936.) 12*s*. 6*d*. net.

THIS work is intended for the average reader who has little knowledge of astronomy, and is written in simple and non-technical language. Some may wonder why the author commenced with the sidereal universe and ended up with the solar system; but this is a minor point which will be lost sight of in the clear and interesting presentation of salient matters in astronomy. In the foreword by Dr. Clyde Fisher reference is made to the wealth of poetical quotations which appear in the different chapters, and many will be grateful for this anthology, ranging from the days of Hebrew cosmogony up to modern times.

A considerable portion—nearly one hundred pages—is devoted to descriptions of the constellations, with numerous diagrams. There are also many illustrations and photographs in the text. The book should stimulate readers to pursue more fully the subjects dealt with in the cursory fashion which is inevitable in the wide survey taken by the author. In the very brief discussion of various matters it is impossible to avoid expressions which may be misleading. Thus, on p. 235, readers might gain the impression that the moon is approaching the earth at present, owing to tidal friction. It is true that our satellite will some day approach us after it has receded a long way from its present orbit, but it is not approaching us now. In Chapter xvi there is little or nothing to show the distinction between the planetismal theory of Chamberlin and Moulton and the tidal theory of Jeans and Jeffreys. These are minor blemishes which do not detract from the value of a very interesting work. M. D.

Electron Tubes in Industry

By Keith Henney. Second edition. Pp. viii + 539. (New York and London: McGraw-Hill Publishing Co., Ltd., 1937.) 30*s*.

THE author is not so much concerned with fundamental scientific ideas as the practical application of electronic devices, and he does this very thoroughly, with ample references to original literature. The general characteristics of vacuum, gaseous, and photo-sensitive tubes are explained and suitable applications indicated, some of which are surprising. The text forms an ideal reference book and should be widely known. L. E. C. H.

The Methodology of Educational Research

By Prof. Carter V. Good, Prof. A. S. Barr and Douglas E. Scales. (Appleton Series in Supervision and Teaching). Pp. xxi + 882. (New York and London: D. Appleton-Century Co., Inc., 1936.) 16*s*. net.

A SURVEY of the chief methods used in educational research, together with a list of those problems which the authors consider suitable for university research workers.

America Revisited

By Dr. G. W. C. Kaye, O.B.E.

EVEN in depressed times, America is a stimulating country to visit, and I found the present national outlook a good deal more subdued than on the occasions of my previous visits; one, ten years ago at the height of a boom period, the other, during the Great War. Even so, the public and industrial activities of the United States seem to have lost little of their customary courage. San Francisco, lacking a site for its projected International Exhibition in 1939, has not hesitated to create one in the shape of an artificial island, some 400 acres in extent, in the middle of the bay. Not content with this, the city has just spent twenty-three million pounds in four years on two large new bridges, one of them, across the Golden Gate, having a record span of 4,200 feet. New York City is building at monumental expense a new elevated high-speed roadway along the water-front of Manhattan Island to try to relieve the traffic congestion, while Los Angeles is constructing road tunnels with the same object.

Americans, one gathers, pride themselves on owning more cars than any other nation. Traffic problems in the big cities are proportionately acute: it appears that on a normal weekday a quarter of a million cars enter New York and leave it, and that in the early afternoon some 35,000 cars are parked in busy streets. Incidentally, no lights are required on cars parked in American streets at night. There are relatively few buses and most of the passenger traffic in New York is carried by the 'subway' (underground). This is cheap (2½*d.* everywhere), noisy, foul but fast, and the rush-hour scenes are incredible. The elevated railways in both New York and Chicago are an unmitigated eye-sore and a noisesome blight upon the unfortunate streets which hold them.

Thousands of miles of magnificent highways, beautifully graded and cambered, have been built all over the States, largely by 'volunteer' battalions as a palliative for unemployment. Dual tracks and flying junctions lead to high cruising speeds—60 m.p.h. or more seemed to be commonplace. The published annual death-roll from motor accidents in the States is considerably higher than with us—it was nearly 40,000 in 1937, that is, nearly twice as large as ours in proportion to the population.

The roads in residential areas gain in attractiveness from the American custom of no fences in front of houses. It follows that there is little or no privacy in the gardens or "yards", but none is apparently desired. The Americans have a great aptitude for coining words; 'mortition' I knew of old, but 'beautician' must have come in with the countless beauty parlours.

Continuous demolition and rebuilding and disorganized streets seem to delight the New Yorker, who regards them as a sign of progress and doesn't mind being a little late to-day for the sake of being a little early to-morrow. New Yorkers claim, too, with no apparent contrition, that they possess the noisiest street corner in the world. Public apathy recently helped to terminate the existence of the Noise Abatement Commission. In a room on the sixteenth story, I found the noise of the elevated railway nearby was intolerably loud. On the twenty-seventh story it was beneficial to shut the windows, when telephoning, in order to cut out the rumble of the street traffic.

Most American cities seem to possess skyscrapers, partly in emulation, one supposes, of New York, where the newer skyscrapers are really beautiful by day, and almost fairylike by night when floodlit or when picked out by the lights of the windows of the occupied rooms. I noted, incidentally, that the express elevators usually allowed one second per floor (though sometimes less) whether going up or down. The tall isolated buildings of the new Rockefeller Centre and Radio City, which occupy some 12 acres, arrest attention by their dignified grouping.

Air-conditioning, which one finds in public rooms throughout the States, is a valuable addition to the amenities of railroad travel, particularly in the warmer south. The cooled and filtered air enters from the roofs of the coaches, the chilling being effected either by ice or by refrigerators, and the filtering by asbestos mats or the like. Some of the transcontinental railways run high-speed 'limited' trains on certain days in the week, largely to meet the growing competition of air travel, which is well organized and popular, being well suited to the great distances. In Canada the air carriage of freight, which already greatly exceeds that of any other country, being one third of the total for the world, is acclaimed as an outstanding boon for the widely scattered settlements.

Public interest in scientific matters appears to be high: popular scientific and technical journals of many and varied types cater in abundance on

the bookstalls for the multitudes of young men who want to make good in the world. Public lectures gather large audiences, and no public dinner or luncheon is apparently complete without a post-prandial lecturer, who will find himself attentively and closely followed. Uplift movements of all kinds receive the enthusiastic support of the women, whose domestic arrangements seem to afford them more leisure than with us. There is a strong and growing movement, so I was told, for a five-day week for all classes of workers, though I should hazard that, class for class, the men work longer hours per day than in Great Britain. Their leisure is never too scanty, however, to prevent their showering on the English traveller kindly and proverbial hospitality: it is impossible to acknowledge their friendliness to England too appreciatively.

New York abounds with interest for the visitor with scientific leanings—Columbia University, the Bell Telephone Laboratories, the National Broadcasting Co., the 'Long-Distance' building for telephone and radio-telephone circuits. Everywhere one experienced boundless keenness, enthusiasm, knowledgeability, and friendliness.

The two capital cities of Canada and the States well repay a visit. Ottawa, which is being subjected to a measure of replanning, occupies a site of great natural beauty. Among the recent buildings are the palatial National Research Laboratories which, finely situated on the bank of the Ottawa River, are playing an ever-increasing part in Canada's industrial affairs. Washington must surely be one of the most beautiful cities in the world, with its stately buildings and wide avenues bordering on the Potomac River and Park. White marble and Greek architecture are adhered to for public and Governmental buildings in the environs of the Capitol, among the more recent additions being the magnificent Supreme Court and the Folger Shakespeare Library with its replica of the old Globe Theatre. The dignified building of the National Academy of Sciences stages permanently a fine series of working exhibits of fundamental experiments, which the public eagerly frequents. Some four miles away is the National Bureau of Standards, sister institution to the National Physical Laboratory, and with many problems in common.

Western America provides a powerful magnet for the visitor, in the shape of the Canadian Rockies, the Yosemite Valley, the Big Trees, the National Parks, the Grand Canyon, and the gracious beauty of San Francisco where the delightful climate, sea fogs and western geniality make an Englishman feel thoroughly at home. At Berkeley, a few miles away, the University of California exemplifies the scale of grandeur on which so many of the American and Canadian universities have been established. Among much that is intriguing are the full-scale daily newspapers which the students control, finance, publish and edit at some of the universities. Berkeley rejoices in a fine campus and many magnificent buildings, including a Greek theatre holding 10,000 and a sports stadium for 90,000. It is here that E. O. Lawrence by his genius and persistency has developed the cyclotron into the most potent practical contribution of recent times to the study of neutrons and artificial radioactivity. I refer to this again later. Thirty miles south at Palo Alto, is the Leland Stanford University, the buildings of which are most attractive with walls of buff-coloured sandstone and red-tiled roofs in the old Spanish mission style. Among much else of interest is a 2 million-volt transformer outfit, the insulating supports of which were braced with temporary steel strutting. This, I learnt on inquiry, was a precautionary measure in readiness for the next great earthquake, which was about due!

Los Angeles, that city of astounding growth and spacious conceptions, confronted with the problems of overcoming desert conditions, has solved them with gigantic irrigation schemes. Water is distributed lavishly: lawns are only kept alive by almost continuous sprinkling. Fruit is amazingly cheap. Here are the fine new buildings of the University of California, the University of Southern California, and the renowned and immense film studios of Hollywood, a city which merges completely into Los Angeles. Near by is the 'Hollywood Bowl'—a natural hillside auditorium capable of holding forty thousand people and possessing marvellous natural acoustics, which are reinforced by a large 'shell' reflector enabling those in the remotest seats 550 feet away to hear easily. The Bowl is famous for its "Symphonies under the Stars". The stable and agreeable climate enables outdoor social functions to be held with certainty.

Ten miles away near the hills is Pasadena, with its famous California Institute of Technology. Among much of interest is the Kellogg radiation laboratory where Dr. C. C. Lauritsen's pioneer work on super-voltage X-ray therapy is being carried out. In another building one can see the process of grinding the 200-inch reflector which, when completed in about two years' time, is intended for Mount Palomar, a hundred miles away, as the night glare of Los Angeles has grown to interfere with some of the work at Mount Wilson. Incidentally, there is now a magnificent road up to the 5,700-ft. summit of Mount Wilson, the journey by car from Pasadena taking about an hour, a very different state of things from that which prevailed a few years ago. The Observatory lays itself out to attract visitors, some twenty

thousand attending the lectures and demonstrations during the year. A similar public response meets the efforts of the Observatory in Griffith Park, overlooking Los Angeles, visitors flocking to see the planetarium and astronomical working models.

While much of Chicago is drab and drear, the new and reclaimed portion on the shore of Lake Michigan is remarkably attractive. In September last at Chicago, the Fifth International Congress of Radiology, with some 2,800 members from forty nations, held its meetings and housed its members in a single hotel equipped with suitable convention halls and some two thousand bedrooms. Under the efficient presidency of Dr. A. C. Christie of Washington, several hundred papers were down for reading: they were dealt with by nine different sections, which met concurrently, apart from a few general sessions. The enthusiasm of members was catered for by programmes of meetings and educational courses which, together with intervals for sustenance, went on daily from 8 a.m. until midnight or after. Any unemployed moments could be devoted to a large scientific and industrial exhibition of apparatus. Many examples of shock-proof high-voltage X-ray apparatus were on view, together with associated devices designed primarily for the study of neutrons and nuclear physics.

The radiophysics section was mainly devoted to the measurement and generation of very short wave radiation, that is, X-rays generated by voltages of the order of a million volts, and radium gamma rays. Some of the papers were of extreme interest. As regards the production of very high voltages, America, always a pioneer in such matters, is now paying widespread attention to the use of super-voltages, not only for nuclear physics research, but also for X-ray therapy for cancer treatment. As against radium therapy, the arguments advanced are that it is not yet proved or ruled out that the shorter gamma rays have any clinical advantage over X-rays, while the latter, though bearing higher maintenance charges, offer the advantages of a lower initial cost and the possibility of implanting greater depth doses in the body. There appeared, however, to be a considerable body of opinion which doubted whether there is as yet any sound clinical evidence which could establish a real superiority of million-volt X-ray therapy over, say, 200 or 400 kv. therapy.

Quite apart from the achievements of the high-voltage electrical engineer for commercial utilities, there have recently been developed for physical and clinical purposes a number of radically different methods for generating very high voltages: (*a*) the super-tension transformer, (*b*) the radio-oscillator generator, (*c*) the electrostatic generator of the belt type, (*d*) the cyclotron.

Million-volt transformers of which some part or other of the high-voltage circuit is in the open air, are of necessity so large as to require a special building to house them; there are numerous examples operating X-ray tubes, neutron tubes, etc., mainly in the States, but also elsewhere. The principle of mounting both transformer and X-ray tube in a common oil tank has long been familiar, but it has now been extended to voltages of 400 kv. and upwards. In a recent development of high-voltage X-ray apparatus by Dr. Coolidge, only the earthed target-end of the tube emerges from the tank. The advantageous features of this type of outfit are the freedom from electrical dangers, the relatively small amount of lead protection required, the accessibility of the target, and, perhaps, most of all, the small space needed, the dimensions of the outfit being of the order of only a few feet. Recent experiments on the replacement of transformer oil by compressed gaseous dielectrics are likely, it is anticipated, to lead to high-tension generators of even more modest dimensions.

Examples of radio-oscillator resonance X-ray generators, designed by Dr. D. H. Sloan, are to be found in New York and San Francisco. A short-wave radio oscillator sends its power into a high-voltage resonance coil mounted within a metal vacuum tank which serves as the X-ray tube and which is continuously evacuated. The hot cathode is situated in the side of the tank directly facing the X-ray target, which is mounted on the bottom of the coil where there is a voltage maximum, so that the high voltage is generated entirely within the X-ray tube precisely where it is to be used.

Electrostatic machines were largely used in the early days of X-rays, and the electrostatic high-voltage generator of the endless-belt type, which we owe to Van de Graaff, is virtually a large Holtz machine, consisting essentially of a rounded conducting terminal supported on an insulating column and charged by a swiftly moving (4,000–5,000 feet a minute) flat insulating belt (of rubberized fabric) conveying electricity 'sprayed' on the belt by corona points charged with 20,000 volts, and depositing it within the terminal. The outfit is robust and simple, and very high and steady voltages (several million) may be obtained. The current output is proportional to the speed and number of the belts and the dielectric strength of the surrounding medium, usually air. There are now a number of these installations in the States; I saw an early type at the Carnegie Institution (Dept. of Terrestrial Magnetism) at Washington. This produces a million volts with regularity: the only uncertainty is occasioned by the high humidity which often occurs in Washington. This difficulty will be avoided in the new 5 million-volt

apparatus which is being constructed, and which will operate at several atmospheres pressure within a large pear-shaped steel reservoir (some 60 or 70 feet high), mounted vertically on its small end. This outfit is designed for work on nuclear physics. Another outfit at the Huntington Memorial Hospital, Boston, operates a continuously pumped cascade X-ray tube at a million volts and up to three milliamperes; while yet another outfit, at the Massachusetts Institute of Technology, develops a steady voltage of five million and a current of two milliamperes in work on atomic disintegration.

The cyclotron was designed for use in the domain of atomic physics and, while it is inapplicable at present to X-ray purposes, it does, as already mentioned, render available for the biological worker and radiologist two powerful new tools, in the shape of artificial radioactive elements and neutrons. Some twenty-five outfits are at present under construction the world over, six or seven in the States and two in England (Cambridge and Liverpool).

The latest model of the cyclotron, which incidentally weighs 100 tons, utilizes the principle of multiple or 'cascade' acceleration of ions by a combination of a magnetic and a swiftly alternating electric field, and can so impart to a beam of protons or deuterons equivalent voltages up to 7½ million. If the beam is allowed to impinge on beryllium, a stream of neutrons results which may be some thousands of times more powerful than any other method can provide. For example, a beam of neutrons corresponding to 7½ million volts and 20 microamperes is stated to be equivalent to the gamma radiation from 100,000 grams of radium in equilibrium. The controls for the operator are remotely situated from the cyclotron, further protection being afforded by tanks of water three feet thick encircling the apparatus.

By the use of one or other of the three types of particle which the cyclotron provides in such abundance, virtually all the known elements have been made to yield radioactive isotopes through the method of nuclear bombardment. Among them is radio bismuth, which is identical with radium-E in every respect. In one day as much radio sodium (with a half-life of 15 hours) can be made as corresponds to 100 mgm. of radium. Some of the artificial radioactive elements are finding a revolutionary field of service as 'tracers' or 'tagged atoms' in biological and clinical research. For example, radio sodium, when drunk in a solution of common salt, manifests itself in the fingers of the hand in less than two minutes by the emission of gamma rays; the residue, magnesium, is quite innocuous within a few days.

Both in Berkeley and elsewhere the study of neutron therapy (on animals) is being taken up. Neutrons ionize in a manner very different from that of gamma or X-rays, and are unique in being more absorbable in body tissue than in bone. If the present claims of selective reaction to tumour tissue are substantiated, it would seem that neutrons may presently have high therapeutic significance.

Prof. Lawrence has under construction a special building for housing a much larger cyclotron, which has been designed expressly to generate radioactive elements for prosecuting bio-physical and medical research. The new outfit, which will weigh 220 tons, is expected to afford voltages equivalent to 10 million, and to give five or ten times the yield of the present cyclotron.

It is the practice of the International Radiological Units and Protection Committees to meet on the occasions of the International Congress. The chief business before the Units Committee, which met under the chairmanship of Dr. Failla of New York, was to determine whether or not the time had come when the röntgen—the ionization unit of X-ray quantity—should also be used for very high-voltage rays and radium gamma rays. The British delegates (Dr. N. S. Finzi, Prof. F. L. Hopwood and Dr. G. W. C. Kaye) presented a memorandum from the British X-ray Units Committee, which advocated the step and with it an appropriate modification of the present definition of the röntgen. In the end, the important step was taken and a generalized definition was agreed provisionally until the next Congress, when it was anticipated that a still more general definition embracing all classes of radiation may be forthcoming. The röntgen is now defined as follows: "The röntgen (symbol r) shall be the quantity of X- or gamma-radiation such that the associated corpuscular emission per 0·001293* gramme of air produces, in air, ions carrying 1 electrostatic unit of quantity of electricity of either sign."

The International Protection Committee, which met under the chairmanship of Dr. Kaye, made a number of changes in the existing recommendations, particularly in relation to the new problems of protecting operators working with super-voltage X-rays or radium 'bombs' containing large quantities of radium. Many of the data utilized were based on recently published results of the National Physical Laboratory.

It was announced during the Congress that the next meeting would be held in Berlin in 1940 under the presidency of Dr. Holthusen of Hamburg. It will be governed by a new set of rules and regulations adopted at Chicago, largely through the energy and initiative of Dr. Christie.

* 0·001293 gramme is the mass of 1 c.c. of dry atmospheric air at 0° C., and 76 cm. of mercury pressure.

Quaternary Glaciations in Central China

DR. J. S. LEE, the well-known Chinese geologist, has sent to the Editor of NATURE the proofs of a monograph entitled "Quaternary Glaciations in the Lushan Area, Central China" with a series of photographs, intended in the first place for publication in vol. 2, ser. B, of *Academia Sinica*. Its transfer to England by air transport, with the request that it be placed in the safe custody of a responsible geological institution, conjures up a lively sense of the present and future state of affairs in China; which aspect, however, has no part in this article except in its bearing on the future publication of the monograph. Another aspect, and one having some significance, is that one would scarcely expect Dr. Lee to take such care to ensure the preservation of this material and to have it brought to the critical notice of expert glacialists, if he were not confident of the prime importance of his latest investigations in the Lushan mountain massif.

A few words of explanation are perhaps necessary to a proper understanding of the latter remarks. The very existence of evidences of glaciation in Central China has in the past been questioned by many geologists with experience of glaciated districts. When Dr. Lee in 1934 published his first account of the 'Boulder Clays', striated rocks, transported blocks, etc., in the Lower Yangtze Valley, and invoked true glaciation (as against solifluxion and allied phenomena) to explain the facts, his evidence was challenged by G. L. Barbour after a cursory joint traverse of the ground.

Barbour, while admitting the extraordinary character of many of the deposits, sought to identify them with long periods of abnormal subærial weathering and erosion, possibly commencing so far back as early Pliocene or even Miocene times. The clay matrix of the 'Boulder Clay' was likened to non-glacial loam; the presence of boulders he explained as due to sinking into the leached soil of laterized surface rocks followed by gradual descent to lower ground under gravity; while a theoretical series of structural events was postulated to account for the presence of transported blocks in elevated positions relative to their apparent source. Further, an absence of (1) glacial sculpture, (2) glacio-fluviatile deposits, and (3) *roches moutonnées* was claimed by Barbour, though it was admitted that shortage of time prevented his seeing many crucial features.

At that time (1934), Barbour was clearly inclined to the belief that the glacial explanation of the Lushan phenomena was not acceptable. Yet he paid high compliment to Lee for "his penetrating recognition of the possible significance of this extraordinary geological occurrence", admitting further that the last word on the matter had not yet been said and that his (Lee's) interpretation had not been disproved.

That Dr. Lee was not deterred by these criticisms from a geologist of wide experience is shown by his energetic pursuit of confirmatory evidence, and the monograph under consideration directs attention to this glacial evidence under the headings (*a*) geomorphological indications; (*b*) moraines and their associated deposits; (*c*) striated rocks. A short account of the bed-rocks of the Lushan is given to enforce the arguments dealing with transported blocks; and more ambitious inferences than previously attempted are introduced to demonstrate a three-fold glaciation of the Yangtze valley.

A well-contoured map of the Lushan, bounded on the north by the Yangtze River and on the east by the Poyang Lake, accompanies the monograph. It shows the geographical extent of the glaciations and includes the observed indications of fluvio-glacial deposits, terminal and lateral moraines, drainage channels, glacial striæ, and striated boulders. The scale of the map is 1 : 50,000.

A critical review of the monograph is thought to be undesirable here. For it is clear that, failing an intimate knowledge of the area, an unquestioning acceptance of the validity of the glacial terminology must precede any attempt to estimate the full value of the evidence. This assumption is supported by the fact that G. L. Barbour, well experienced in low-latitude glacial phenomena, was unable to put forward final and convincing conclusions regarding the Lushan deposits and allied features. Attention will therefore be confined to a summary of the chief points of interest raised by Dr. Lee. Glacial geologists, by permission of the Editor of NATURE in arrangement with the Director of the Geological Survey and Museum, will be afforded the opportunity of consulting the monograph and map at the Survey Library, where the documents are being housed pending further instructions from Dr. Lee.

In his analysis of the glacial evidence, Dr. Lee stresses the fact that landforms have suffered extensive erosion and consequent modification since the last glacial period. The geomorphological indications are therefore not in themselves conclusive; but they were sufficient to inspire Lee and induce him to search for other signs of glacial

Fig. 1.

A LENTICULAR MASS OF HARDENED AND LATERIZED BOULDER CLAY OF THE POYANG PERIOD INVOLVED IN THE LOOSER BOULDER CLAY OF THE TAKU PERIOD, NEAR THE KUTANG VILLAGE.

phenenoma. The frequent occurrence of rock basins on the top and flank of the northern part of the Lushan is noted, but not accepted indiscriminately as evidence of glacial sculpture. A strong case, however, is made for a true cirque on the central heights at a spot where a circular depression is carved out of resistant rock of uniform composition, free from structural weakness. It has a fairly steep back-wall and hangs to a main valley in front; further examples on the south-eastern flank are also described.

A circumstantial account is given of the most striking example of a U-shaped valley seen in the area, namely, the Wangchiapo Valley. One feature is worthy of Lee's own words: "The question therefore arises as to whether the U-shape of the valley is not entirely due to the synclinal structure with the non-resistant Kuniuling rocks being more or less completely removed by stream erosion. That this is not entirely true is indicated by the behaviour of the existing streams and by the deposition of terminal moraines which still survive. . . . Here it suffices to note the occurrence of a deep ravine through which the stream pours down the valley. This feature has been incised by the stream and has attained a depth of no less than 70 m. below the floor of the valley at Wangchiapo. . . . Beds of the Wulafoeng Grit are thereby excavated in the form of a trench; and curiously enough, the trench does not run along the axis of the syncline or the lowest part of the valley bottom but along the side of it." The ravine begins abruptly in front of a mass of Boulder Clay "which proved to be the remnant of an end moraine", and here is a slight similarity to certain drift-diverted streams and gorges in Lancashire. Another case of drainage which suggests the former existence of a valley glacier is described from the Chilichung Valley.

In connexion with several dry gaps which have been cut into the north-western ridge of sandstone in the Lushan, the statement that "the only feasible explanation of the origin of these gaps seems to be that they were produced by spills from the glacier" is supported by acceptable evidence. Examples are also given, though with varying assurance, of firn basins, corries, and kindred features; more confidence is expressed in the

Fig. 2.

GLACIAL PAVEMENT NEAR PAISHITSUI, STRIÆ POINTING SOUTH-EAST; BEDDING PLANE DIPPING NORTH-WEST AT ABOUT 20°.

case of two "zungenbecken" or "central basins" relics of piedmont glaciers on the north side of the mountain.

Coming now to the important matter of depositional evidence, that is, moraines, boulder-clay, etc., we are presented with an interesting story leading to the postulation of three glaciations, associated with three distinct types of boulder-clay. The two lowland types are illustrated in Fig. 1, which shows the incorporation of blocks of the earlier well consolidated dark red variety by the later brick-red less consolidated one. The latter is more widespread and has undergone less laterization. It is important to note, in view of Barbour's earlier objection that the boulders in the boulder-clay were invariably hard quartzites and grit, that Lee now emphasizes their lithological variety. Lateral and terminal moraines, a block moraine, and an outwash apron are instanced, though a fuller development of these is said to be lacking as a result of excessive, inter- and post-glacial destruction. Solifluxion has been found inadequate to explain the transfer of large blocks over the long distances required; the famous Poyang Lake section of glacial drift containing such boulders is 9 km. from their source in the Lushan, and the intervening pre-glacial gradient is negligible, yet is, according to Lee, demonstrably greater than in Boulder Clay times.

Finally, the scratched boulders and striated rock surfaces (Fig. 2) are claimed by Lee to be perhaps the most convincing evidence for glacial operation, and it need only be remarked that Barbour's scepticism on this matter must have created in Lee a strong urge to test this type of evidence very thoroughly. W. L.

Obituary Notices

Dr. G. E. Hale, For.Mem.R.S.

BY the death of George Ellery Hale on February 22, at Pasadena, California, solar physics loses its greatest leader. Born in Chicago on June 29, 1868, he had already in 1890, before completing his studies at the Massachusetts Institute of Technology, begun working at the Harvard College Observatory on his idea of a spectroheliograph. Resisting the temptation to accept Prof. Holden's offer of opportunities to develop his new instrument in connexon with the 36-in. refractor at the Lick Observatory, he established with his father's help a private observatory at Kenwood, in a suburb of Chicago. There, working in the fourth order of a 4-in. Rowland grating attached to a 12·2-in. equatorial, he studied the spectrum of the solar prominences and photographed them in monochromatic light, using first of all the bright K line of calcium. As he found by photographic spectroscopic observations that the bright K_2 line could be detected here and there on the disk of the sun, he extended his work to monochromatic studies of the whole solar disk, finding the presence of great areas of glowing calcium clouds in general around sunspots. By 1892, his pioneer work had won for him recognition by the University of Chicago, of which he became an associate professor.

Through the munificence of C. T. Yerkes, by no means the last wealthy man in whom Hale was to inspire confidence in his ability to make excellent use of large benefactions, he was given charge of the new Yerkes Observatory at Williams Bay, Wisconsin, with the largest refractor in the world (40-in.) and with the Rumford spectroheliograph, which gave him an image of the sun 6·5 inches in diameter. At the Yerkes Observatory with Barnard, Burnham and Frost to help him he worked steadily for nearly ten years on stellar spectra and solar problems. The next great instrumental development became possible for him in 1904, through the generous assistance of the Carnegie Institution, when he was made director of the Mount Wilson Observatory. Here he successfully developed the tower telescope (60 ft. and later 150 ft.) with underground spectrographs (30 ft. and 75 ft.) for solar work; for high dispersion stellar spectra and work on distant nebulæ the 60-in. and 100-in. reflectors were available, the latter being due to the munificence of J. D. Hooker. He gathered a great team of colleagues together, and the publication of the annual report of the Observatory became one of the major events of the astronomical year. Hale's own contributions were mainly on the solar side and included such outstanding discoveries as that of the intense magnetic fields in single sunspots, the existence of bipolarity in groups of spots of opposite polarity, the change of polarity of such bipolar spots after each sunspot minimum and the relatively weak general magnetic field of the sun (a full account of Hale's solar work is given in an article by Prof. H. F. Newall in the series of Scientific Worthies in NATURE of July 1, 1933, p. 1).

In 1923, under the strain of his many activities, Dr. Hale's health gave way and he retired from the active directorship of the Observatory to become honorary director. But his work was not done. On the observational side, he developed the spectrohelioscope, now a valuable instrument in the study of solar eruptions of short duration and of their reaction on the terrestrial ionosphere; on the administrative side he was mainly responsible for securing in 1928 the grant from the Education Branch of the Rockefeller Foundation, which made it possible to undertake the heavy task of constructing a reflecting telescope with a mirror 200 in. in diameter. Hale took a large share in the preliminary

studies and work necessary for the successful completion of this project.

As an investigator, Hale did as much as one man could be expected to do. But his scientific activities covered a much wider range. As foreign secretary of the National Academy of Sciences he was active in establishing the National Research Council of the United States, of which he remained honorary chairman until his death. His international work in astronomy began in 1895 with the foundation of the *Astrophysical Journal*, following upon the publication three years earlier of *Astronomy and Astro-Physics*.

Then in 1904 at St. Louis came the foundation of the International Solar Union on Hale's initiative. President at its first meeting, he, with Schuster and Arrhenius, was elected on to its first executive committee, remaining a member of it throughout the life of the Union. In 1919 came the formation of the International Research Council with Hale as an active member of the original executive committee; later he became president for the years 1934–37 of the International Council of Scientific Unions. In the International Astronomical Union formed under the auspices of the Council, Hale was elected president of the Commission of Solar Physics (1919–25).

Honours and awards came to Hale freely from scientific bodies and universities all over the world. To mention only those from Great Britain, they included honorary degrees from Oxford, Cambridge and Manchester, medals from the Royal Institution and the Royal Astronomical Society, of which latter body he was an associate. Foreign membership was given him by the Royal Societies of Edinburgh and Dublin, by the Cambridge Philosophical Society and by the Royal Society, which in 1932 awarded him the Copley Medal, primarily for his work on magnetic fields in the sun.

F. J. M. STRATTON.

ANYONE meeting George Ellery Hale must, I think, have felt at once that he was somewhat out of the ordinary run of scientific men. We knew he was a great figure in science, but felt that he could have been equally great at almost anything else. For Nature had not only endowed him with those qualities that make for success in science—a powerful and acute intellect, a reflective mind, imagination, patience and perseverance—but also in ample measure with qualities which make for success in other walks of life—a capacity for forming rapid and accurate judgments of men, of situations, and of plans of action; a habit of looking to the future, and thinking always in terms of improvements and extensions; a driving-power which was given no rest until it had brought his plans and schemes to fruition; eagerness, enthusiasm, and above all a sympathetic personality of great charm. This great and varied array of talents gained for him the complete confidence of everyone he met, from the highest to the lowest.

I never ceased marvelling at his great knowledge of almost every department of observatory work. He was not only for many years director of the great observatory which was so largely his own creation, but also had made himself an expert in most of its varied branches; and I know from my own experience how genuinely he could interest himself in other people's scientific work and ideas, and how warmly and sincerely he could give encouragement.

It was a great tragedy that indifferent health so restricted his activities in the latter years of his life—his ever-eager mind and ardent spirit had made too exacting demands on a none too strong body; it is an even more poignant tragedy that he has not lived to see the completion of the great new telescope which will owe so much to his forethought and planning.

J. H. JEANS.

THE death of Dr. G. E. Hale, coming at the end of a slow decline of strength such as he has suffered since July 1936, can scarcely be regarded as other than a merciful release from protracted suffering. The sincere sympathy of his very numerous friends goes forth to his wife and family and relatives, and the memory of a very remarkable personality will be widely cherished.

His geniality and his interest in a wide extent of natural knowledge and of art and literature and history made him a very welcome companion.

Hale was in truth a leader not only in his own chosen investigations in solar physics but also in the initiation and furthering of organization of scientific co-operation. By a rare combination of personal qualifications of which he seemed to be entirely unconscious, he achieved early in life recognition of his power to evoke enthusiastic support in developing available resources for the advancement of natural knowledge. In 1890 he had resisted an offer of the director of the Observatory on Mount Hamilton in California, an offer that he should have the use of the Lick refractor during stated hours in the week for the development of his spectroheliograph. Fortunately, through the wise advice of his father, he decided to utilize full time with a 12-in. refractor specially constructed at the expense of his father. After a couple of years of successful observations in the Kenwood Observatory he was called upon to take charge of the new observatory in Wisconsin, where a finished product of the workmanship of Alvan Clark in the form of a 40-inch achromatic objective, which Hale's enthusiasm had induced Mr. C. T. Yerkes to purchase, was to be mounted in the Yerkes Observatory of the University of Chicago.

In 1904, Hale received noble encouragement from the trustees of the Carnegie Institution to found a Solar Observatory in California, and there he began that very notable succession of advances based on experimental trial on relatively small scale and leading to successively increased power of instrumental equipment on novel lines. Aided by funds contributed by the Carnegie Institution, by Miss Snow, by Mr. J. D. Hooker, by the Rockefeller Foundation and probably also by other sources, there arose on Mount Wilson the observatory provided with extensive workshops and physical laboratories and devoted to the intensive study of all branches of astronomy and many branches of physics.

There, under the stimulating influence of Hale in the encouragement of team work, not only were opportunities of a very unusual kind afforded to the members of the devoted permanent staff, but also welcome was extended to students of recognized authority from all parts of the world, to join in co-operative work.

Even in the resulting activity, Hale himself found time and energy to produce very notable scientific contributions, such as his splendid discovery (based on Zeeman's discovery of the influence of a magnetic field on spectral lines of a gas rendered luminous in such a field) that sunspots were the seats of violent magnetic phenomena and that the sun showed signs of having a general magnetic field, with poles not far removed from the poles of the axis of the sun's rotation. One of his latest achievements was the invention of his beautiful spectroheliioscope for visually studying local changes of short duration in the features of the sun's surface—a study that seems likely to throw light not only on the cosmical origin of terrestrial magnetic storms and of the aurora borealis, but also on certain peculiar phenomena encountered in the reception of wireless signals, which seem to indicate the arrival of external influences (probably of solar origin) in the outer atmosphere of the earth.

Truly Hale was a leader of outstanding ability, and his influence and memory will long be cherished. His many friends will join in a deep regret that it was not given to him to live to see the completion of that huge enterprise of the 200-in. reflector, in the initiation of which he took so deep an interest.

H. F. NEWALL.

THE most prominent characteristics of Dr. Hale were his whole-hearted devotion to astronomy and his friendship with his colleagues and fellow workers. His invention of the spectroheliograph and spectrohelioscope and his discovery of the magnetic field in sunspots are tributes to his mechanical genius and insight. The two magnificent observatories and the 200-in. telescope are outstanding achievements. But he had also a very catholic interest in the work of his colleagues all over the world, and was always ready to give them help. The Solar Union had Hale for father and, as wittily said by a German astronomer, Schuster for mother. He attached great value to good fellowship among astronomers, amateur and professional alike, for the advancement of the science.

I shall always remember the times I have met Hale and the complete absence of any superiority or what is vulgarly but expressively called 'side'. The last occasion when I saw him was some seven or eight years ago, when he invited Sir Herbert Jackson, Prof. A. Fowler and me to lunch, and we heard of his project for the 200-in. reflector. Another time he was passing through Edinburgh after a visit to Andrew Carnegie at Skibo Castle, and was hugely delighted at having beaten Andrew at golf and caught a bigger fish. He was a great man, and I, with many more, am proud to have been among his friends.

F. W. DYSON.

Mr. C. Green

THE death of Charles Green, chief inspector of fisheries in the Fisheries Branch of the Department of Agriculture of Eire, on February 9, after a short illness, came as an unexpected shock to his friends.

He was born in 1876, the only son of the Rev. William Spotswood Green, a well-known alpine climber and organizer of deep-sea trawling expeditions, and was educated at St. Edward's School, Oxford. After taking a degree, with a gold medal in natural science, in Trinity College, Dublin, he was, in 1900, appointed a naturalist on the staff of the newly constituted Fisheries Branch, afterwards becoming inspector and, later, chief inspector.

Though his official duties tended to direct his attention more to the legislative and administrative side of fishery affairs, of which his knowledge was extensive and profound, Green kept in close touch with recent biological research, and it was due largely to his insistence that the dictum, laid down by his predecessors, that fishery administration must have an adequate biological basis, continued to receive due official recognition. His loss will be realized most fully by his immediate friends and colleagues, for most of his work was done under the cloak of official anonymity.

Until other claims on his time became more pressing, Green often attended the meetings of the International Council for the Exploration of the Sea, first as an expert on the staff of the British delegation and later as a delegate from the Irish Free State.

He was for many years an active member of the Council of the Dublin Zoological Gardens, and was elected a vice-president shortly before his death.

G. P. F.

WE regret to announce the death of Prof. Wladyslaw Grabski at Warsaw on March 1, after a long and painful illness. He had been rector and lecturer at the Polish Agricultural College and was an authority on the economics of agriculture. After the Great War and the liberation of Poland, Prof. Grabski became a prominent statesman, first as Minister of Agriculture and later as Finance Minister. During his period in office, he founded the State Agrarian Bank and also the Bank of Poland. In 1925, Prof. Grabski retired from political life and returned, as principal, to his old college.

WE regret to announce the following deaths:

Mr. Charles Benson, formerly deputy director of the Agricultural Department, Madras, known for his work on Indian cotton and tobacco, on March 5, aged eighty-two years.

Prof. Alfred Fischel, formerly professor of experimental embryology in the University of Vienna and editor of the *Zeitschrift für Wissenschaftliche Biologie*, aged sixty-nine years.

Prof. Friedrich von Krüger, for many years director of the Department of Physiological Chemistry in the Rostock Institute of Physiology, aged seventy-six years.

News and Views

Prof. I. M. Heilbron, F.R.S.

PROF. I. M. HEILBRON, whose appointment to the chair of organic chemistry in the University of London (Imperial College) has just been announced, is a man of many activities, that of a research director and teacher of organic chemistry being exceptionally prominent. Prior to the Great War, he held a lieutenancy in the A.S.C., 52nd Division, and proceeded to G.H.Q., Salonika in 1917. He was promoted lieutenant-colonel and assistant director of supplies, G.H.O., Salonika in 1918, and was given the D.S.O. and mentioned three times in despatches. It is, however, as a research chemist rather than as a soldier that he will be best recognized. His field, for many years past, has been in the sterol group and in matters generally relating to calciferol and the group which contains the important vitamin D; he has instituted a series of experiments on the synthesis of vitamin A and has progressed definitely towards a successful conclusion of this problem. He has also covered a wide field in other directions, particularly in connexion with the Algæ and carotenoid pigments. Since 1933, he has been able to give full scope to his genius and has made many important discoveries by the help of the large research school which he has gathered together. He was lecturer in the Royal Technical College, Glasgow, from 1919 until 1920; Heath Harrison professor of organic chemistry in the University of Liverpool in 1922–33, and thereafter professor of organic chemistry in the University of Manchester, succeeding Prof. A. Lapworth in the Sir Samuel Hoare chair in 1935.

Dr. J. S. Turner

DR. J. S. TURNER, senior demonstrator in botany in the University of Cambridge, has been appointed to the chair of botany in the University of Melbourne, in succession to the late Prof. A. J. Ewart. From the Sheffield Central Secondary School, Dr. Turner went up to Cambridge in 1927 as a scholar of Selwyn College, and after obtaining first classes in both parts of the Natural Sciences Tripos commenced research on plant respiration under Dr. F. F. Blackman in 1930. He was afterwards elected, successively, to the Frank Smart and Allen studentships in the University, and was awarded the Gedge prize for an essay on respiration in plants. He was appointed University demonstrator in 1934, and since 1936 has been in charge of the large practical classes for Part 1 of the Tripos in the Cambridge Botany School. His main research interest has been in plant physiology, especially in the relationship between respiration and fermentation in yeast and in the tissues of the higher plants. At present, he is engaged on a study of photosynthesis and respiration in aquatic plants. He is also much interested in ecology, and in association with Dr. H. Godwin has contributed substantially to the elucidation of the plant communities of Wicken Fen and the Norfolk Broads. In 1936 he organized a party of research workers to investigate the natural oakwoods of the Killarney district, and in other ways also he has been most successful in stimulating students to work in the field. At Melbourne, Dr. Turner will have a much wider sphere of work; with his enthusiasm as a teacher, and a happy combination of interest in laboratory and field experimentation, he assumes this important professorship with every augury of success.

Dr. Willis Jackson

DR. WILLIS JACKSON has been appointed to succeed Prof. Robert Beattie, who retires in September from the Edward Stocks Massey chair of electrotechnics in the University of Manchester, which he has occupied since 1912. Prof. Beattie has been associated with the University since 1896. Dr. Jackson was educated at Burnley Grammar School and the University of Manchester, where he graduated with first-class honours in 1925, and was the recipient of various prizes and scholarships. He has held the posts of lecturer in electrical engineering at Bradford Technical College and the Manchester College of Technology, and of lecturer in engineering science in the University of Oxford. Since 1936, he has been research engineer to the Metropolitan-Vickers Electrical Co., Ltd., and lecturer and tutor at the Board of Education Summer School for Engineering Teachers in Technical Colleges. His research work has been mainly devoted to high-frequency measurements and to the properties of insulating materials, and has appeared in numerous papers published in the *Proceedings of the Royal Society*, the *Journal of the Institution of Electrical Engineers*, the *Philosophical Magazine* and other journals.

Prof. Alexander Low

THE Court of the University of Aberdeen has accepted the resignation of Prof. Alexander Low, regius professor of anatomy in the University, to take effect on September 30. Prof. Low has occupied the chair since 1925, when he succeeded Prof. Robert Reid, whose assistant he had been for many years. Born in 1868, he was educated at the Aberdeen Grammar School and in the University of Aberdeen, afterwards studying at Freiburg, Vienna and Zurich. His association with Aberdeen as student and teacher covers a period of more than fifty-two years. In his professional studies, Prof. Low has specialized in anthropology and embryology, and has contributed a considerable number of papers to the journals of learned societies in anatomy, anthropology and

embryology. He was one of the original members of the Aberdeen University Anthropological Society, to which British archæology is indebted for its contributions by excavation to early studies of the osteology of the 'beaker-folk'. For many years Prof. Low has been an active member of the anthropological section of the British Association.

Oxford's Programme of Development

A YEAR ago the University of Oxford appealed to its friends for endowment on a scale appropriate to the part it is called upon to play in the world of learning to-day. The response was £426,000. This sum, with the new foundation of Nuffield College for the study of the social sciences, will provide for many of the needs which were mentioned in the appeal. It is strongly felt, however, that further development should take place, and for this a new appeal, which will remain open until July 31, has recently been made. The sum now asked for is £250,000. The most urgent need at the moment is the creation of a general research fund, both for the humanities and for the natural sciences. In the past ten years the number of research students at Oxford has doubled, and throughout the University there is a keen spirit of research. To endow a promising piece of research, whatever it may be, whenever an original line has been struck out, a research fund of £100,000 is regarded as essential. For the development of research in archæology it will be necessary to complete the extension of the Ashmolean Museum, and for this £15,000 will be required. It is felt also that as soon as possible the Departments of Physiology and Botany should have new laboratories. Towards the costs of these £60,000 and £40,000 are required. Lastly, another £35,000 is needed to complete and maintain the new physical chemistry laboratory that is to be erected. These sums make up the £250,000 which is being asked for.

Transatlantic Steam Navigation

IN connexion with the centenary of the inauguration of regular steam passages between Great Britain and the United States by the four steamers *Sirius*, *Great Western*, *Royal William* and *Liverpool*, which all crossed and recrossed the Atlantic in 1838, a special exhibition has been arranged at the Science Museum to illustrate "One Hundred Years of Transatlantic Steam Navigation". The central feature of the exhibition is the magnificent model of the *Queen Mary*, the model being 22 ft. long. The gallery also contains models of the *Normandie*, the *Conte di Savoia* and other notable vessels of recent years. Of greater historic interest, however, are the newly made models of the *Sirius* and *Great Western*. The former ship was of only 703 tons gross and was never intended for work in the Atlantic, but she was the first steamer ever to cross the ocean from east to west using her engines as the main motive power. Her voyage began on April 4, when she left Cork, and ended on April 23, when she tied up in New York harbour. The *Great Western*, designed by the famous engineer Isambard Kingdom Brunel, was of 1,340 tons and it was she which demonstrated in unmistakable manner the possibilities of steam on the ocean. The original drawings of the ship are shown beside the model, and also various interesting documents. Other ships shown are the *Great Britain* and the *Great Eastern*, the *Britannia*, first of Cunard vessels, the *Scotia*, the last of the paddle vessels on the Atlantic, the *Servia*, the first steel liner, and the *Philadelphia*, the first large twin-screw ship on the Atlantic. The exhibition was opened on March 16, and will remain open until the middle of September. An illustrated handbook has been prepared by Mr. H. P. Spratt, the Museum officer who has arranged the exhibition.

Hadrian's Wall

SOME major problems of the Roman Wall of Hadrian would appear to have been brought to a solution by recent excavations of the Durham University Excavation Committee, of which an account was given on March 11 before the Society for the Promotion of Roman Studies by Mr. I. A. Richmond of King's College, Newcastle-on-Tyne, co-director of the investigation with Mr. F. G. Simpson, of the Cumberland Excavation Committee. It is found that the lack of uniformity between the remains in different sectors of the Wall, which has been the main difficulty of the archæologist, is not due to haphazard work, but arises from deliberate changes in plan as the Wall was in course of erection, as well as to the differences in material available for building. From Newcastle to the Irthing the builders began with a wall of stone 10 ft. thick (afterwards reduced to 7½ ft. to expedite the work), erecting barracks for patrols in large courtyard gateways piercing the Wall at every mile, and hence called 'milecastles'. Over the north gate of each and at every 540 yards was a turret. This section of the Wall was then extended eastward to Wallsend; and a narrow stone wall built to the westward between milecastles 49 and 53; but in the main westward extension from the Irthing to Bowness-on-Solway, limestone for grout was lacking, and a turf wall took the place of the stone wall. It was supplied with stone turrets of distinctive type and milecastles of wood. This turf wall was replaced by a stone wall later in the century.

TACTICAL considerations now took the place of time and material, which had previously determined changes in plan. When the Wall was completed, eight forts were embodied in the line, holding either 500 cavalry or a nominal 1,000 infantry. Thus was formed a front line force capable of taking the offensive in overwhelming strength. It had been found that the Wall, designed originally as a patrol line, could be better used for concentrated garrisons, and thenceforward the emphasis was on forts rather than milecastles. Next in order comes the Vallum, the earthwork of which the ditch is the main feature, south of the Wall, the purpose of which has been the subject of much controversy. Mr. Richmond is of the opinion that it demarcates the military zone of the Wall and its

dependent structures and also served as a barrier against southern marauders. Further excavation may show whether this view is to be regarded as final.

Toxicology of Narcotic Drugs

IN his presidential address before the Society of Public Analysts delivered on March 4, Dr. G. Roche Lynch discussed "The Toxicology of the Narcotic Drugs", embodying observations regarding the barbiturates, thio-barbiturates, straight-chain ureides and morphine, based on his own record of cases. He pointed out that the barbiturates, of which seventeen are now on the market, can be divided into two main groups, one of which produces light narcosis of long duration and the other deep narcosis of shorter duration. The individual barbiturates differ greatly in the rate at which they are destroyed in the body; some are destroyed so rapidly that it is rarely possible to recover more than minute quantities of them from urine or tissues. The extent of their use is illustrated by the fact that 18 million tablets of one of them, and that not the most common, are produced annually. The habit of taking them at night regularly is widespread, especially among women; but in keeping them within reach as a means of inducing sleep there is a danger that, after one or two tablets have been taken, a state of 'automatism' might supervene, in which a person, more or less unconsciously, might take a further number, with serious results. For purposes of treatment, the analyst should be able, by examination of urine, to ascertain within a quarter of an hour whether or not a barbiturate had been taken; but for purposes of evidence in court a complete identification with melting point determination is desirable.

Broadcasting Television

IN a discussion in the House of Commons on March 11 of the supplementary estimate for £360,000 for the B.B.C., Major Tryon made some very satisfactory remarks. He pointed out that in this year's report there were two entirely new features. First there was the expansion of television which accounted for an additional £295,000, and also about £15,000 proposed for broadcasting news in foreign languages. The latter sum was not included in the original estimate as it was not a part of the policy of the Government. He said that Great Britain was the first country in the world to have a public television service. It had been found by the Television Advisory Committee that further experiments must be made before new recommendations could be accepted for extension. That was a scientific inquiry, and he was sure that the House would like to pay tribute to the men of science who had made this wonderful discovery, and to the B.B.C. and its engineers for bringing it into working order. He also expressed the gratitude of the Government to the Television Advisory Committee, under the chairmanship of Lord Selsdon, who had been given great help in scientific matters by Sir Frank Smith. The additional sum required for television was provided simply. In the future 8 per cent of the licence revenue should go to the B.B.C. to help with the additional work. Television had only lately been started and the cost had been very heavy. If the service was to be efficient there must be a greater accommodation of studios, etc. The technical standards of television had been stabilized for three years, and that gave security to producers of sets and encouraged them to make more sets and more cheaply. This grant would foster the growth and development of an infant industry in which we were at present leading the world.

The British Broadcasting Corporation

THE eleventh annual report of the British Broadcasting Corporation, which covers the year ended December 31, 1937, refers to the completion of the first year of operation of the London Television Station, and the year's experience is regarded as having justified the confidence in the future of television which led to its establishment. Financial uncertainty which had complicated further plans was relieved towards the end of the year by the Treasury's acceptance of the view that the costs involved should be met by a grant from the balance of net licence revenue retained by the Treasury. The adoption of the Marconi-E.M.I. transmitting standards as a single system in February made it possible to widen the scope of television programmes during the year, notably in outside broadcasts. Reference is also made in the report to the work of the Talks Advisory Committee, to attempts to promote closer contact with listeners and various experiments in technique. The Engineering Section of the report refers to developments in Empire service and to the obstacle which lack of sufficient wave-lengths continues to present to the planning of extensions to the home service. Further progress in experimental studio design has been made, and improved methods were adopted in the acoustical treatment of studios under construction. The results of research on the performance of short-wave directional aerials were successfully applied in the design of the Empire station. The total income for the year amounted to £3,356,074, of which 85·67 per cent was derived from licences and 14·32 per cent from publications. Of this income, more than 51 per cent was expended on programmes and nearly 18 per cent of the remainder on engineering. £200,000 were transferred to capital account, an amount insufficient to cover the year's expenditure on fixed assets. The report stresses the impossibility of building up any reserve funds in liquid form, although this is most essential while income is still increasing.

Promotion of International Co-operation

THE annual Bulletin of League of Nations Teaching, just issued by the secretariat (No. 4, December 1937), deals with the teaching of the facts and principles of international co-operation, this subtitle indicating that its scope has been extended to cover a wider field than the activities of the League

of Nations itself. The activities of the Advisory Committee on League of Nations Teaching continue to be reflected in the volume, which as in previous years gives publicity to those League activities likely to be of particular interest to educationists. The admirable series of articles in the present volume, particularly those on the role of intellectual co-operation in contemporary life and on the use of modern means of spreading information in the cause of peace, give it, however, strong claims on the attention of all who are studying or seeking to promote international co-operation and understanding. Moreover, the articles on the League of Nations at work, which covers the problem of raw materials and the League of Nations; the reform of the League; the League of Nations and International Hygiene; and Changing Aspects of Child Welfare, and on the International Labour Organisation, dealing particularly with the raising of the minimum age of admission to employment, represent concise and balanced surveys of the present situation of these problems which should be of real service to the speaker or general student. The reprints of broadcasts such as that on nutrition and the Singapore Health Bureau, of Sir Malcolm Delevigne on opium and drugs, and of Prof. Gilbert Murray on intellectual co-operation, provide other material of the same type.

Copper and Brass Welding in Germany

In 1936, the Deutches Kupfer Institut of Berlin published a valuable pamphlet describing carefully the best methods of welding copper and brass. The Copper Development Association of London has now translated this into English. It is pointed out that there are certain differences between German and British welding practice, mainly associated with the general employment in Great Britain of deoxidized copper. But knowing the high standard of excellence which has been achieved in Germany, there is much of it which will be of value to British readers. The hand-made copper and bronze domestic vessels shown in the Berlin State Museum and dating back thousands of years prove that soldering and riveting were in common practice from very early times. In course of time, the necessity arose for a new and improved jointing technique which would produce smooth and strong joints and yet avoid the expense of riveting. This demand is universally met to-day by the adoption of welding. The development of copper welding has been much slower than that of steel, but the difficulties in the way have now been largely overcome, and welded copper appliances of the highest quality are now produced. Deoxidized coppers, which are extensively used in Great Britain, are not discussed in this pamphlet. The thermal conductivity of copper is about six times that of steel. Molten copper readily dissolves other metals and forms the basis of several important alloys. With zinc it produces brass and with tin bronze. The thermal conductivity of brass is two or three times that of steel, and only about one third that of copper. This feature is a decided advantage in welding. For this reason, brass requires a smaller flame for welding than copper. Although gas welding is the one most commonly used, new electrical methods are in process of development which will probably enable arc welding to be profitably employed.

The Clock of the Future

At the British Horological Institute in London, on January 12, an interesting discussion was held on the respective merits of spring-wound and electric clocks. Mr. D. W. Barrett, of Smith's English Clocks, Ltd., began by pointing out that his firm has large investments in spring-driven clocks and its business was founded on them. He claimed to be impartial and he would not have taken up the electric type had he not been assured of its future. A spring-wound clock cannot be relied upon to give accurate time. It needs regular winding and its parts are delicate. The electric clock needs no attention and is robust. It is true that it stops when the current fails, but on the average this only happens once a year. There are areas where no break has been recorded for three years. In the United States, 66 per cent of the sales were of electric clocks. In Great Britain about 33 per cent of the money spent on clocks last year was for electric clocks of the synchronous type. When it is remembered that the spring-wound clock has been in existence for three hundred years whilst the electric clock has only been on the market for some seven years it will be seen that the latter is the more popular. There are about 45 million clocks in use in Great Britain, the bulk of them being spring-driven. There can be little doubt but that the electric clock will be the clock of the future. It is practically immune from the effects of heat and damp.

The Soviet Institute of Physical Problems

Part 3 of the *Physics Bulletin* of the Soviet Academy of Sciences for 1937 contains Dr. P. Kapitza's address to the Academy last March, which he devoted to an account of the new Institute founded by decree of December 1934. The building, which has taken a year longer to complete than was anticipated, is, although only 80 metres from Moscow tram lines, surrounded by gardens in which other institutes of the Academy are to be built. It nearly surrounds a quadrangle 40 m. × 25 m., with outer walls 63 m. × 50 m., the long side nearly north and south. The south-eastern corner is not built on, and gives access to the quadrangle. The main laboratories are on the ground floor, and provision for very sensitive apparatus is made in the basement. A first floor over the eastern block is occupied by the administrative department. By introducing a simplified system of book-keeping, Dr. Kapitza has reduced the five accountants originally thought necessary to one. The apparatus taken from Cambridge has been installed and is described. It includes the Metropolitan-Vickers alternator and the coil through which it is short-circuited to produce for 1/100 sec. an intense magnetic field, the hydrogen liquefier producing 7 litres per hour and the helium liquefier which first cools the gas to 65° absolute by means of liquid nitrogen, then

to 10° abs. by adiabatic expansion and finally liquefies it by the Joule-Kelvin cooling. A new machine on this plan is now being constructed to work with a double cycle and deliver 6–8 litres per hour.

History of American Agricultural Research

A "History of Agricultural Experimentation in the United States, 1607–1925", by A. C. True, has just been issued as Miscellaneous Publication No. 251 by the United States Department of Agriculture, Washington, D.C. This is the third official monograph in a series intended to give a comprehensive summary of the history of agricultural education, extension and research in the United States, the two previously issued having dealt with agricultural instruction in schools and colleges, and the history of agricultural extension work respectively. The present volume naturally begins with the work of private individuals including some biographical information, and shows how they and organizations such as the geological surveys and the Patent Office, themselves little concerned with research, laid the foundations of public agencies for agricultural investigation. It will be noted with interest that the first governmental movement to help agriculture was made when George Washington was president, while Federal State aid for the agricultural experiment stations, founded by pioneers all over the country, was secured by Hatch in 1887 by the passage of an Act bearing his name. The rapid development of research from this period up to 1913, the effects of the Great War and the agricultural depression of 1921–25 are then described in detail. A bibliography of more than three hundred references is appended. These are limited to sources of information used in the text and to bibliographical sketches of some of the leading figures in the earlier periods of agricultural development in the United States.

Marine Fauna of the Isle of Man

THE publication of a new local fauna list is always an event of some interest, and it is of importance when it concerns such historic ground as that of the sea around the Isle of Man ("Marine Fauna of the Isle of Man". Compiled by Dr. Hilary B. Moore. Editor: Dr. R. J. Daniel, assisted by J. R. Bruce and Dr. M. W. Parke. University Press of Liverpool, 1937. 2*s*.). This up-to-date list of the marine animals found in that region is therefore to be warmly welcomed. Future visitors to the Biological Station at Port Erin will be grateful to Dr. Moore, a former member of its staff, for his work of compilation. He has been wise in following the same general plan as that of the well-known "Plymouth Marine Fauna", giving after each recorded name a reference to a good description, adding notes on the ecology, and breeding dates when known. There are three charts and a general introduction describing the most accessible and typical grounds. Dr. Moore and the editors have done their work well, while the printers have succeeded in producing well-balanced and attractive pages. As a work of reference, this list will be much used; to those studying the marine ecology of our islands it will be invaluable. We should like to suggest that in future editions a note be included as to the origin of the ancient drawing of a viking ship which so attractively adorns the cover.

The Film in Education

IN "The Film in Relation to the School Curriculum" (pp. 70; price 1*s*.) the Central Information Bureau for Educational Films, Ltd., has provided a useful reprint of a series of articles which appeared in *Film Progress* from July 1936 until July 1937. It deals with the teaching of geography, natural history, natural science and physical training. The advice given is in close accord with the Board of Education's "Suggestions for the Consideration of Teachers", "Suggestions on Health Education" and "Science in Senior Schools", long excerpts from which are reproduced. A report to the Manchester Education Committee on experimental film-teaching is quoted in support of the assertion that children are stimulated by this means to further effort in geography and nature-study. It is claimed that their interest and mental activity are so aroused as to lead them to seek out knowledge for themselves, their powers of observation and memory are increased and, in the case of geography lessons, the film tends to eliminate anti-foreign bias. Although some teachers prefer still pictures, it seems obvious that these cannot compete with such films as "The Life-Cycle of a Plant", "The Blowfly", "The Amœba" and physical training films.

Battersea Polytechnic

IN its recently published report for 1936–37 the Battersea Polytechnic directs attention to the increased volume and high standard of its research work. In the past, this has been pursued mainly in chemistry, physics and mathematics, but new facilities have made possible extended programmes in the Mechanical and Civil Engineering Department. In the Electrical Engineering Department, the demand for accommodation for research work could not be fully met. For researches in chemistry two Ph.D. and one M.Sc. were awarded by the University of London. Fifty-four other degrees of the University of London and thirty-four National Certificates in Engineering were obtained in addition to many other examination successes. An enumeration of positions obtained by Polytechnic students during the past thirteen years includes 1,218 domestic science inspectors, teachers, organizers and practitioners, 413 engineers, 413 health visitors, sanitary inspectors, nurses, etc., 233 chemists and 97 art practitioners. The general recognition of the enormous national importance of sound teaching in domestic science may be expected to lead to increased activity in this department of the Polytechnic.

The Plant Hormone Committee

As the outcome of a meeting held at the Royal Botanic Gardens, Kew, on November 6 (see NATURE, 141, 88; 1938), a Committee, to be known as "The

Plant Hormone Committee" has been formed with the following membership: Mr. F. P. Knight (Knap Hill Nursery Co.), Dr. C. R. Metcalfe (Kew, convener and secretary), Mr. F. O. Mosley (Lowe and Shawyer, Ltd.), Prof. R. H. Stoughton (University of Reading), Mr. W. G. Templeman (Imperial Chemical Industries, Ltd.), and Dr. M. A. H. Tincker (Royal Horticultural Society). The terms of reference are "to consider the practical applications of 'phytohormones' in relation to plant cultivation". The committee is at present engaged in compiling a list of species of which cuttings cannot easily be struck even by experienced propagators, in the hope that by intensive experimentation, methods for propagating them successfully may be discovered. Further information about the committee may be obtained from the Secretary.

Announcements

PROF. A. KROGH, professor of animal physiology in the University of Copenhagen, and Prof. L. Lapicque, professor of general physiology in the Sorbonne, have been elected honorary members of the Physiological Society.

THE HON. SIR EVAN CHARTERIS, chairman of the Trustees of the National Portrait Gallery since 1928, chairman of the Tate Gallery Board since 1934, and Trustee of the National Gallery and Wallace Collection; Sir Francis Lewis Castle Floud, High Commissioner of the United Kingdom in Canada, Permanent Secretary, Ministry of Agriculture in 1920–27, chairman of the Board of Customs in 1927–30, and Permanent Secretary, Ministry of Labour in 1930–34; and Sir John Ledingham, director of the Lister Institute and member of the Medical Research Council, have been elected members of the Athenæum under the provisions of Rule II of the Club which empowers the annual election by the Committee of a certain number of persons of distinguished eminence in science, literature, the arts, or for their public services.

DR. BURGESS BARNETT, who was curator of reptiles at the London Zoological Gardens in 1932–37, and since then has been doing research on snake venom, has been appointed superintendent of the Zoological Gardens at Rangoon. Dr. Barnett will take up the new post in June.

PROF. H. ZEISS, of the University of Berlin Institute of Hygiene, has been elected president of the Berlin Microbiological Society in succession to Dr. J. Schumacher.

AT the annual general meeting of the Society of Public Analysts held on March 4, the following officers were elected: *President*, Prof. W. H. Roberts; *Vice-presidents*, B. S. Evans, J. R. Nicholls, W. H. Simmons, T. P. Hilditch (chairman, North of England Section), J. F. Tocher (chairman, Scottish Section); *Hon. treasurer*, E. B. Hughes; *Hon. secretary*, Lewis Eynon.

A VACATION Course on child psychology will be held on April 20–25 at Southlands Training College, Wimbledon Park Side, S.W. The course will be given in two concurrent sections: one for matrons of schools and one for medical officers and teachers. Further information can be obtained from the Secretary of the Child Guidance Council, Woburn House, Upper Woburn Place, London, W.C.1.

THE fifth European Congress of Mental Hygiene will be held at Munich on April 23–24, when the following subjects will be discussed: marriage prophylaxis and mental hygiene; prophylaxis of abuse of narcotics (alcohol, morphia, cocaine and hypnotics); and the importance of occupational therapy in physical and mental diseases.

THE League of Nations has sent a medical mission to the Far East to take measures to prevent or control the spread of epidemics. The mission is headed by Inspector-General Lasnet of the French Academy of Medicine; Dr. Hermann Mooser representing Germany and Dr. Robert Cecil Robertson representing Great Britain. The mission will first visit Hong-Kong and continue its work in south China.

ON the recommendation of their Science Scholarships Committee, the Commissioners of the Royal Commission for the Exhibition of 1851 have decided to increase from £250 to £275 a year the basic value of their overseas scholarships for scientific research, which are offered each year to students from Canada, Australia, New Zealand, South Africa, India and Ireland (Eire). The increase will take effect on April 1, 1938.

THE following awards of medals of the Institute of Patentees have recently been made: Grey-Wilson Memorial Gold Medal to Dr. S. C. Blacktin, for a dust and smoke meter (see NATURE, **140**, 331, 582; 1937); Yorkshire Gold Medal to W. H. Siddle, for a wire-joining tool; Special Silver Medals to Mrs. F. Peace for a superhet washer, J. R. Churchill for a chair, W. McClelland for a balanced two-stroke engine, and to F. W. Mason for an automatic blind control.

THE following appointments and promotions have recently been made in the Colonial Service: B. W. H. Harding, inspector of mines, Kenya; W. G. R. Coates, engineer surveyor, Harbour Department, Hong-Kong; A. Gane, inspector of produce, Nigeria; P. H. Symons, assistant analyst, Medical Department, Hong-Kong; J. Pirie (agricultural superintendent, Gambia), agricultural officer, Nigeria; A. J. Wakefield (deputy director of agriculture), director of agriculture, Tanganyika; P. O. Wiehe (science master, Royal College), plant pathologist, Department of Agriculture, Mauritius; J. H. F. Sharkie (executive engineer, Public Works Department, Gold Coast), waterworks engineer, Public Works Department, Nigeria; J. Shelton (chemist), chief chemist, Institute for Medical Research, Malaya.

Letters to the Editor

The Editor does not hold himself responsible for opinions expressed by his correspondents. He cannot undertake to return, or to correspond with the writers of, rejected manuscripts intended for this or any other part of NATURE. *No notice is taken of anonymous communications.*

NOTES ON POINTS IN SOME OF THIS WEEK'S LETTERS APPEAR ON P. 518.

CORRESPONDENTS ARE INVITED TO ATTACH SIMILAR SUMMARIES TO THEIR COMMUNICATIONS.

Radioactivity produced in Scandium by Fast Neutrons

ON irradiating scandium (^{45}Sc) with fast neutrons of energy $\leqslant 20 \times 10^6$ e.v., Pool, Cork and Thornton[1] observed two positron-emitting radioactive isotopes of scandium of half-lives 52 hours ('strong intensity') and 4 hours ('very strong intensity') respectively. With neutrons of $< 10 \times 10^6$ e.v., neither period could be observed. Previously Walke[2] had given the following assignment of radioactive isotopes of scandium: ^{44}Sc (52 hours), ^{46}Sc ($4{\cdot}0 \pm 0{\cdot}1$ hours), ^{48}Sc ($4{\cdot}1 \pm 0{\cdot}1$ hours). These he attributed to the reactions: ^{39}K$(\alpha,n)^{42}$Sc, ^{41}K$(\alpha,n)^{44}$Sc, ^{46}Ca$(\alpha,p)^{49}$Sc, ^{43}Ca$(d,n)^{45}$Sc and ^{43}Ca$(d,n)^{44}$Sc. Pool, Cork and Thornton suggested that the two periods which they observed were due to the formation of ^{44}Sc and ^{45}Sc resulting from the reactions

$$^{45}\text{Sc} + n = {}^{44}\text{Sc} + 2n - Q_1 \quad . \quad . \quad . \quad (1)$$

and

$$^{45}\text{Sc} + n = {}^{43}\text{Sc} + 3n - Q_2 \quad . \quad . \quad . \quad (2)$$

From the mass defect curve one can expect for the threshold energies the values $Q_1 = (10 \pm 2) \times 10^6$ e.v. and $Q_2 = (18 \pm 2) \times 10^6$ e.v. Energetically, therefore, both reactions might be possible, but the following discussion shows that it is difficult to understand why reaction (2) should take place more frequently than reaction (1).

Consider ^{45}Sc to be bombarded by homogeneous neutrons of energy E and denote by $P_1(E)$ and $P_2(E)$ the probabilities of reactions (1) and (2). P_2 will be zero for $E \leqslant Q_2$, and for $E > Q_2$ the 'evaporation' model indicates that it will increase rapidly with increasing E. It is not until $E - Q_2$ reaches values of the order of a few million electron volts that P_2 and P_1 will be of the same order. Furthermore, with a neutron source of the type used (a thick lithium target bombarded by deuterons of 6×10^6 e.v.), the neutrons of energy $E > Q_2$ will be very small in number compared with those of energy $E > Q_1$. Thus, the number of radioactive nuclei formed according to reaction (2) will be very small compared with the number formed according to (1).

We are therefore led to suspect that the two periods observed must be ascribed to ^{44}Sc and that this nucleus exists in two isomeric forms of half-lives 52 hours and 4·1 hours respectively. This would be consistent with the fact that both periods are obtained by bombarding potassium with α-particles, though previously[2] the 4·1-hr. period has been ascribed to ^{43}Sc. The 4-hr. period observed when calcium is bombarded with deuterons may be partly due to ^{44}Sc and partly to ^{43}Sc.

To test the hypothesis of isomerism we have bombarded scandium with neutrons of maximum energy 14×10^6 e.v. (obtained by bombarding lithium with 950 kv. deuterons) for which reaction (1) only, and not reaction (2), should be energetically possible. We have observed both the 52-hr. and 4-hr. periods with similar initial intensities (corrected for bombarding time). The particles emitted were found to be positrons. The isomerism of ^{44}Sc seems therefore established and the assignment of the radioactive isotopes of scandium should be as follows: ^{44}Sc (52-hr. and 4-hr.), ^{46}Sc (4-hr.). As to the radioactivity of ^{43}Sc, no evidence exists at present.

Gentner[3] has recently observed a 4-hr. period produced in scandium by γ-rays of 17×10^6 e.v. This he ascribes to ^{43}Sc formed in a $(\gamma, 2n)$ reaction. According to our results it appears that this activity should be attributed to ^{44}Sc formed in a (γ, n) reaction.

W. E. BURCHAM.
M. GOLDHABER.
R. D. HILL.

Cavendish Laboratory,
Cambridge.
March 8.

[1] Pool, Cork and Thornton, *Phys. Rev.*, **53**, 41 (1937).
[2] Walke, *Phys. Rev.*, **51**, 439 (1937); **52**, 669 (1937).
[3] *Naturwiss.*, **26**, 109 (1938).

Deviations of Short Radio-Waves from the London-New York Great Circle Path

THE propagation of short radio-waves from England to New York has been found to involve many anomalous effects. Studies have been made of transmissions from Rugby, directed toward New York, and of broadcasts from Daventry using various transmitting arrays. Three multiple unit steerable antennæ (musas) located at the Holmdel, N.J. experimental receiving station of the Bell Telephone Laboratories have been used. One of these is the end-on musa described in a recent paper[1]. The other two are broadside musas steerable horizontally to permit explorations in azimuth. The British Broadcasting Corporation has kindly provided details of the transmitting antennæ in use during the various transmissions. These B.B.C. antennæ, together with the British Post Office transmitting antennæ in use on the London–New York radio telephone circuits, have provided simultaneous comparisons, which are, to a limited degree, representative of the effects of steerable transmitting directivity. Employment of the above facilities during the past eight months has disclosed the following characteristics:

(1) During 'all-daylight' path conditions, the usual multiplicity of waves distributed in or near the great circle plane, which constitutes normal propagation, has invariably been predominant. Neither ionosphere storms nor the catastrophic disturbances associated with short-period fade-outs seem to affect the mode of propagation.

(2) In contrast to (1), during periods of dark or partially illuminated path conditions, the great circle

plane no longer provides the sole transmission path. The extent to which other paths are involved varies greatly.

(*a*) Usually, transmission from mis-directed antennæ is accompanied by weak and scattered waves arriving off the great circle, in addition to normally propagated waves. Transmissions which emphasize radiation to the north especially exhibit such scatterings, arriving from north of the great circle with a considerable azimuthal spread. Acceptance of these scatterings by the receiving antenna results in rapid flutter fading.

(*b*) A considerable number of instances have been observed in which the ionosphere behaves as though it were warped, with resulting shifts of the wave path sometimes to the north and sometimes to the south with little regard to the transmitting directivity.

(*c*) Not uncommonly, the transmission medium displays more complex characteristics in which several azimuthal routes exist, the route selected by the waves depending upon the transmitting antenna. In these circumstances, transmitting antennæ directed, say 20 or 30 degrees off the great circle produce in the received waves, substantial deviations to the corresponding side of the great circle.

(*d*) On rare occasions, propagation during periods of dark, or partially dark, path conditions is entirely normal. That is, the waves travel in or near the great circle plane and are unaffected by the transmitting antenna directivity, except in amplitude.

When the transmitting antenna directivity is appropriate, the characteristic mentioned under (*c*) above often results in two paths sufficiently different in azimuth to be separable by one or the other of the broadside musas. The difference in the transmission time along such paths has sometimes been determinable by the method of audio delay equalization[1]. Such determinations are given in the following table:

Date 1937	E.S.T.	Station. Call	Freq., mc.	Array Direction**	δ_1	δ_2	β_1	β_2	Delay Millisec.
May 28	7.54 p.m.	*GSB*	9·51	260°	11°	43°	2° S.	40° S.	1·50
Aug. 2	7.20 p.m.	*GSF*	15·14	260°			4° S.	34° S.	3·35
„ 2	9.10 p.m.	*GSB*	9·51	260°			8° S.	3° N.	1·00
„ 27	9.30 p.m.	*GSB*	9·51	260°			5° S.	19° S.	0·85
Nov. 19	4.10 p.m.	*GSD*†	11·75	260°/294°	9°	16°	7° N.	7° S.	1·35
„ 19	10.25 p.m.	*GDS**	6·905	288°			4° N.	18° S.	0·80
„ 23	4.35 p.m.	*GSD*†	11·75	260°/294°			4° N.	12° S.	1·40
„ 23	8.00 p.m.	*GSD*†	11·75	294°	2°	21°	1° N.	9° S.	0·47
„ 23	9.00 p.m.	*GSB*†	9·51	260°/306°			2° N.	14° S.	0·94
Dec. 18	8.20 p.m.	*GSC*	9·58	294°			0°	30° S.	2·70
„ 21	7.00 p.m.	*GSC*	9·58	294°	13°	22°	5° S.	8° N.	0·54

E.S.T. = Eastern Standard Time.

δ_1 and δ_2 = 'vertical' angles measured with end-on musa.

β_1 and β_2 = horizontal angles measured with broadside musa, in degrees north (*N.*) or south (*S.*) of the great circle.

Delay is in all cases inserted in the β_1 path. It, therefore, is the shorter path in point of time.

* Rugby.

† Two synchronized transmitters.

** The direction to New York is 288° (measured clockwise from north).

Excepting the northern scatterings mentioned in (*a*), substantial deviations to the north have been rare, but large deviations to the south, such as the 30°–40° values in the table, have been found frequently. Southern deviations appear to be associated with ionosphere storms. In storms of moderate severity, southern deviations appear with noticeable consistency, even on Rugby transmission directed sharply to New York. In such circumstances, Daventry transmissions to the West Indies have been received much better with a low-gain broadside musa steered 60° south of the great circle, than a transmission in the same wave-band directed nearly to New York and received with a rhombic antenna directed towards England. In normal conditions, the superiority is reversed, of course.

It is known that during periods of disturbance the intense magnetic and auroral effects, which are normally found in the auroral zone, extend to more southern latitudes. It has been suggested by my colleague, Mr. W. M. Goodall, that the southern deviations in transmission might be connected with the southward expansion of the auroral zone during disturbed periods. For example, at such times as the zone extends southward to the London–New York great circle, normal transmission might experience great attenuation. Any southern route which may then exist, because of this zone or for other reasons, may then be superior to the great circle route.

C. B. FELDMAN.

Bell Telephone Laboratories, Inc.,
Experimental Receiving Station,
Holmdel, N.J.
Feb. 25.

[1] Friis and Feldman, "A Multiple Unit Steerable Antenna", *Proc. Inst. Radio Eng.*, **25**, No. 7 (July 1937).

Effect of Longitudinal Magnetic Field on the Refractive Index and Conductivity of Ionized Air

THE experimental study of an ionized gas in presence of the magnetic field has recently acquired considerable importance in connexion with the ionosphere. Notable investigations have been made by several authors[1,2,3,4,5] on the effect of the transverse magnetic field on the refractive index and conductivity of the ionized gas. Very few investigations have, however, been made in the case of the longitudinal magnetic field. Mitra and Ghosh[6] have recently observed the magnetic double refraction of ionized air in the presence of longitudinal magnetic field.

During the experimental study of the effect of longitudinal magnetic field on refractive index and conductivity of the ionized air, it was observed by us that in most cases the refractive index and conductivity of the so-called 'extraordinary' wave did not show any commonly assumed tendency to attain infinite values when the magnetic field was gradually increased. The plots of refractive index and conductivity against magnetic field yield curves as shown by the dotted *B* lines in Figs. 1 and 2 respectively. Such curves, however, can only be interpreted by the more complete equations for the refractive index and conductivity, and not by the generally used approximate equations which are obtained by neglecting the collisional frequency (ν) of the electrons. In the present note we point out that in cases where the refractive index and conductivity are measured as the strength of the magnetic field is increased, at a fixed frequency of the initial wave, the collisional frequency ν, however small, should not be neglected.

The complete equations used by us for calculating the square of the refractive index and conductivity (σ in E.S.U.) of an ionized gas in the presence of

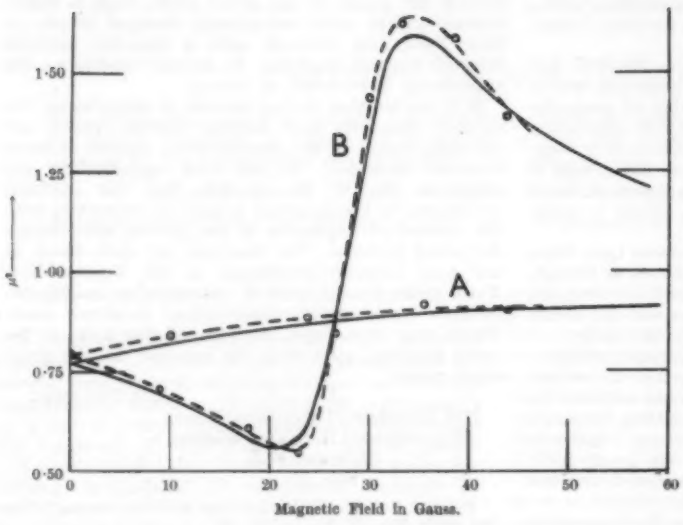

Fig. 1.

a longitudinal magnetic field may be shown to be,

$$\mu^2 = \tfrac{1}{2}\left[1 - \frac{(p \pm p_H)p_e^2}{p\{\nu^2+(p \pm p_H)^2\}} + \sqrt{\frac{p^2\nu^2+(p_e^2-p(p \pm p_H))}{p^2\{\nu^2+(p \pm p_H)^2\}}}\right] \quad . \quad . \quad . \quad (1)$$

$$\sigma = \frac{p_e^2\nu}{4\pi\left[\nu^2 + (p \pm p_H^2)\right]}; \quad . \quad . \quad . \quad . \quad . \quad (2)$$

where $p_H = \dfrac{He}{mc}$, H being the applied longitudinal magnetic field and the rest hold the usual meanings.

In the above equations the so-called 'ordinary' and 'extraordinary' waves are represented by the upper and lower signs of p_H respectively. It will be observed from the above equations that if ν be much smaller than p, in the case of ordinary wave it can be safely neglected for all values of p_H, since ν has to be compared with $p+p_H$. In the case of the extraordinary wave, however, ν cannot always be neglected even when it is considerably smaller than p, as ν has then to be compared with $p-p_H$, the value of which tends to become zero when p_H approaches p.

The arrangement of the apparatus was a modification of that adapted by Mitra and Ghosh[6]. As the intensity of the wave emerging from the discharge tube is considerably reduced due to absorption, a system consisting of a Hertzian dipole aerial was used in the output of an ultra-short wave oscillator for producing the impressed wave ($\lambda = 3{\cdot}71$ metres) and also at the input end of the Lecher wires. The conductivity was determined from the knowledge of leakance per unit length of the Lecher wires, which was measured by the method employed by one of us in connexion with the measurement of radiation resistance of transmission lines[7]. The refractive index was found by the usual method from the values of wave-lengths in air and in the ionized medium.

Figs. 1 and 2, as already described, show the variations of the square of the refractive index and conductivity of ionized air when the magnetic field is gradually increased. The dotted curves are drawn from the experimentally observed values, and continuous ones from those calculated by equations (1) and (2). The curves for the ordinary and extraordinary waves are represented by *A* and *B* respectively. It will be observed from Fig. 2 that the maximum conductivity of the ionized air is obtained in the same region (near about $p = p_H$) where the irregularity appears in the values of refractive index, as shown in Fig. 1. From the above curves it will be seen that the inclusion of ν in equations (1) and (2) prevents the refractive index and conductivity from attaining infinite values.

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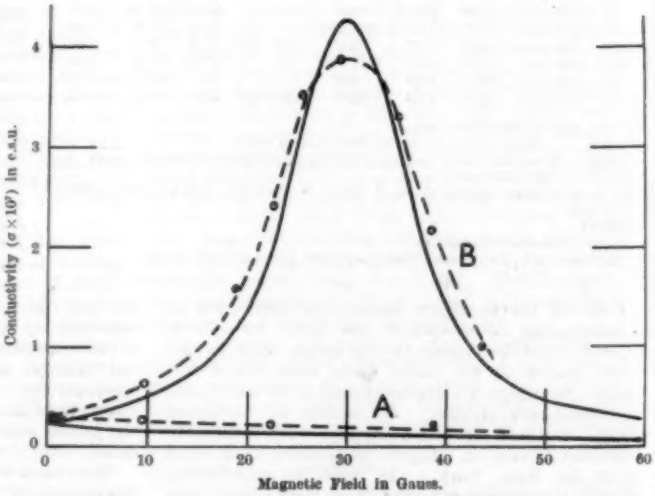

Fig. 2.

X-Ray Study of Isoprene, Butadiene and Chloroprene at Low Temperature

In view of the considerable technical importance of isoprene, butadiene and chloroprene, as the hydrocarbons which on polymerization give natural and synthetic rubber, some interest is attached to the study of their structure. At normal temperatures they are in the liquid or gaseous state, and as it is possible to make exact X-ray structure measurements only in the solid state, the substances have been examined at liquid nitrogen and liquid oxygen temperatures, in a Debye-Scherrer camera, of radius 57 mm., employing a simple technique developed in the Davy Faraday Research Laboratory. Exposures of 30–90 minutes at 100 ma. were given.

Butadiene gives an extremely good X-ray diagram with about 35 measurable lines. Although the photograph provides adequate data as to crystal spacings, it has not been possible to identify the diagram with that of any of the crystal classes of high symmetry. It is probable that this substance is a crystal of a class which makes an analysis by the Debye-Scherrer method extremely difficult, if not impossible. The spacings calculated from the 10 strongest lines, using the Bragg relation, are given in the following table. The intensities are visual estimates.

Line	Butadiene intensity	Cu $K\alpha$ radiation $\theta°$	d in A.
1	8	9·49	4·67
2	6	10·49	4·23
3	7	10·86	4·08
4	10	12·52	3·55
5	10	12·84	3·47
6	8	13·52	3·30
7	8	13·94	3·19
8	6	19·82	2·27
9	5	20·30	2·22
10	6	21·42	2·08

With long exposures chloroprene never gave diagrams showing more than three lines corresponding to spacings of 3·28, 2·57 and 2·32 A., and two diffuse 'liquid' rings the maxima of which corresponded to spacings of 11·78 and 3·24 A.

Isoprene (Schuckert) never seems to crystallize at all sharply, but gives a glassy mass. This is in accordance with the facts quoted by Beilstein. It is not therefore surprising that only 'liquid' rings appear on the X-ray diagrams. (This substance was also studied using a 35 kw. tube with a rotating iron anticathode. Even a long exposure with an intense X-ray beam failed to bring out any lines.) A photometer trace of one of the films indicated intensity maxima corresponding to spacings of 8·6, 2·4 and 2·0 A.

It is not proposed to continue this work for the present. The purpose of this note is simply to put on record the preliminary results which have been obtained.

I am indebted to Dr. W. J. S. Naunton of Imperial Chemical Industries, Ltd., for supplying me with the chloroprene and butadiene, and to Sir William Bragg and the Managers of the Royal Institution for the facilities they have afforded me.

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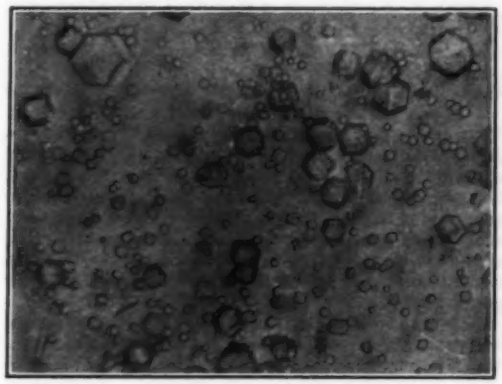
A Plant Virus Preparation in a Fully Crystalline State

Specific proteins, believed to be the viruses themselves, have been isolated from plants infected separately with each of seven viruses of the tobacco mosaic and potato virus 'X' groups[1–4]. Although these proteins have some properties in common with crystalline materials, and can be obtained in both solid and liquid anisotropic states, the solid preparations yet obtained lack the three dimensional regularity characteristic of true crystals. The particles of all these viruses are rod-shaped, and the connexion between this and the formation of fibres or pseudo-crystals has already been discussed[2,5].



Preparation of Bushy Stunt virus crystallized from ammonium sulphate solution. × 200.

From tomato plants infected with the virus causing bushy stunt[6], we have now isolated a specific protein which crystallizes in the form of rhombic dodecahedra. Solutions of this protein do not show anisotropy of flow, and the jelly formed by sedimenting the protein in a centrifugal field of 16,000 times gravity is not birefringent. As the crystals belong to the cubic system, they also are isotropic.

Infections (local lesions) of *Nicotiana glutinosa* can be obtained by rubbing the leaves with 1 c.c. of solutions containing 10^{-7} gm. of the protein, and 1 c.c. containing 10^{-6} gm. gives a visible precipitate with its antiserum. The activity of a preparation is unaffected by repeated recrystallizations or by sedimentation in a high-speed centrifuge.

After clarifying the infective sap by heating to 60° C. and centrifuging, the protein is isolated by repeated precipitations at room temperature with one quarter saturated ammonium sulphate solution. Impure preparations can also be fractionated by means of trypsin or a high-speed centrifuge. Crystallization is most readily effected by adding ammonium sulphate to a neutral solution at room temperature until the first sign of turbidity appears, immediately cooling to 0° C., and then slowly warming up to room temperature. The protein is much less soluble at room temperature than at 0° C., and as the clear fluid warms it becomes turbid and the protein crystallizes.

Analyses on dried preparations have given the following results: carbon 47, hydrogen 7·3, nitrogen 16, phosphorus 1·3 and carbohydrate 6 per cent.

This protein, like those we have isolated from plants infected with other viruses, appears to be a nucleoprotein, but it differs from them by having a rather higher nucleic acid content.

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Heterochromatic (Inert) Regions in the Chromosomes of *Crepis capillaris*

GENETIC investigations on the inert regions in *Drosophila*[1,2] in connexion with the cytological studies on heterochromatin (inert chromatin) and the chromocentre[3–7] showed that the chromosomes have active (euchromatic) and inert (heterochromatic) segments; the proximal parts, near the centromeres, being the heterochromatic ones. These regions conjugate in the chromocentre in the salivary gland nuclei.

The data reported by Sturtevant[3] on the preferential segregation in triplo-IV female *Drosophila melanogaster* and those by Kikkawa[5], who studied haplo-IV *Drosophila ananasse*, indicating a probable conjugation between *Y* and IV chromosomes, suggested that non-homologous chromosomes most probably conjugate in the inert regions. More convincing evidence in this respect was supplied by Gershenson (in press) in studying the preferential segregation in triplo-IV flies having XY + fragmented *X*. Direct cytological evidence was supplied by Prokofieva[10], who showed that the second (inert) arm of IV chromosomes conjugate with the inert region of the left arm of the third chromosome.

A series of cytogenetic phenomena that occur in plants can be best interpreted if one assumes a conjugation between the inert regions of the non-homologous chromosomes. Heitz[11] and others showed that plant chromosomes (especially the sex chromosomes) have heterochromatic regions, but an exact analysis of the whole karyotypes, as in *Drosophila*[12], has not yet been carried out; therefore we have attempted to analyse the chromosomes of *Crepis capillaris*. This species has three distinct pairs of chromosomes: *A*, *C*, and *D*. Hæmatoxylin preparations with completely black chromosomes were slightly stained (fixation—Lewitzky-chromic acid-formalin). The proximal regions in each pair and the very distal ends remained darker, while the regions in between became lighter (see accompanying illustration). It should be noted here that the heterochromatic regions were not always exactly equal in length in all preparations. In some preparations the heterochromatin of the distal region (end) of *C* and *D* chromosomes were scarcely noticeable. We cannot decide yet whether in these particular cases it was completely lacking, or whether the chromosomes were highly stained. It is probable that the slight variations in length of the heterochromatic regions is due to the difference in density of euchromatin and heterochromatin. Perhaps such regions are partially active. In studying the karyotypes of *Secale* species[14] and *Nicotiana* species (Kostoff, unpublished), euchromatic and chromatic regions have been also found (compare chromosome 1 of *Secale Vavilovii*)[14].

The above data (also some others that cannot be mentioned here owing to limitation of space) in connexion with data reported by other investigators, a part of which is mentioned above, demand a revision of some cytogenetic conceptions and suggest new interpretations of known phenomena.

McClintock's data[15], for example, upon the non-homologous chromosome conjugations in *Zea* can be explained by assuming a conjugation between inert regions. 'Fold backs' of the univalents are results of attraction of inert regions. Her data as well as Avdulov's data[16] showed that in *Zea* even whole inert chromosomes occur. The terminal conjugation of the non-homologous chromosomes in haploids, as for example in *Triticum monococcum* ($n = 7$)[17,18], is obviously due to conjugation of distal heterochromatic regions of the non-homologous chromosomes. Numerous 'mutual' translocations in *Crepis* reported by many authors can be interpreted by the assumption of somatic interchange in conjugating inert regions. This concerns only the dynamics of the phenomenon. Stern[19] supplied convincing data for the occurrence of somatic crossing-over, and Peto[20] (in plant somatic tissue) and Levan[21] (in pollen) found direct cytological evidences.

Demerec and Hoover[22] found a viable deficiency. They wrote: "The deficiency 260–5 does not involve any of the visible extant loci. It takes a section of at least four bands at the tip end of the *X* chromosome. Flies homozygous for this deficiency are viable and fertile. They do not show any visible peculiarities." This deficiency is viable because it probably involves only the inert region. When one examines the drawings by Prokofieva[13] (Figs. 1, 4, 5 and 6) one sees that the very distal end of the *X* chromosome is inert.

In the light of these studies, it would be interesting to find out how much of the catenation in *Œnothera* is due to chromosome homology of the distal regions and how much to the conjugation between inert regions of the distal ends. *Œnothera* mutations, which are consequences of structural changes, might

as well result from interchange in the inert regions of non-homologous chromosomes.

The probable role of the inert regions in interspecific hybridization and in evolution will be discussed elsewhere.

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Occurrence of the Freshwater Medusa, *Craspedacusta sowerbii*, in Eastern Canada

SOME four years ago, we[1] had the pleasure of recording in NATURE the occurrence of the freshwater medusa, *Limnocnida rhodesiæ*, from new localities that increased its southern range in Africa. In the present communication we wish to give some details regarding the finding of the freshwater hydromedusa, *Craspedacusta sowerbii*, in the Province of Quebec, Canada, these being the first records of its occurrence in Canada, so far as can be ascertained.

Freshwater medusæ were first observed by Sowerby in June, 1880, in the *Victoria regia* tank in the Royal Botanic Gardens, Kew, and were described and named *Craspedacustes sowerbii* by Lankester[2] in the same year. The spelling of the name has since been modified to *Craspedacusta*. The first record of the hydroid or polyp phase was made by Parsons in 1884 from tanks in the Royal Botanic Gardens. Since then *Craspedacusta* has been notified from a number of places in the British Isles, France, Germany, Holland, Austria, Czechoslovakia, Poland and Russia. In Asia, *Craspedacusta* have been recorded from open waters in China and Japan. In the United States there are a number of records covering a large area of the country and forming a somewhat compact block of States. These States are Michigan, Illinois, Indiana, Ohio, Pennsylvania, New York, Missouri, Kentucky, Virginia, Washington, D.C., Oklahoma, Louisiana, Alabama and Georgia. The medusa has also been found in the Gatun Lake, Panama Canal Zone and in Brazil.

Two records, both of unexpected findings of *Craspedacusta*, are here presented for Canada. The first time that the medusa was obtained was on a hot afternoon in late June, 1934, when we were collecting aquatic fauna from the margins of Horseshoe Lake, which lies at the foot of Lake Manitou, a few miles from St. Agathe des Monts, Quebec Province. Horseshoe Lake is approximately at lat. 46° N., long. 74·25° W. It is a natural lake, about 800 yards long, 350 yards wide, with a maximum depth of 50 feet. Three mature medusæ were found among reeds at a shallow spot and several very small ones were recovered from the plankton then collected. Prolonged search and stirring of the water and silt with poles failed to reveal more medusæ, nor were any hydroid stages found. The mature medusæ were all females and were 10–12 mm. in diameter. There were numerous Protozoa, Entomostraca and tadpoles present, so that abundance of food for the medusæ was available. Subsequent searches by friends and ourselves at Horseshoe Lake have been negative for *Craspedacusta*.

The second habitat for the medusa in Canada is from a locality between Cantik, Quebec Province, and Rouse's Point, New York State, United States, these places being the Customs and Immigration Stations of Canada and the United States respectively, on either side of the international frontier. A naturalist friend sent us a bottle containing seventeen medusæ, which he had found accidentally when searching for a lost ball in September 1938. Rouse's Point is in lat. 44·58° N., long. 73·25° W., according to several gazetteers. The exact site of collection cannot be given, but the collector was very definite that the medusæ were found well on the Canadian side of the boundary, in a hollow containing about two feet of water, with abundance of grass and rushes. The weather was hot at the time of collection and the water was warm. Four days later the area was visited again, but no medusæ were found. The medusæ collected earlier were preserved in formalin and were in good condition when we received them. On examination, all of them were found to be females. They varied from 7 mm. to 15 mm. in diameter, most of them being between 10 mm. and 11 mm. in diameter.

Mature *Craspedacusta* from both localities were typical specimens. The umbrella was not very thick, the mesoglœa being up to 1 mm. thick in those measured. The manubrium was quadrangular and there were four lip-like projections around the relatively small mouth. The four radial canals were well-marked, arising from the angles of the manubrium and passing to the rather voluminous peripheral ring canal. The nettle ring was distinct and somewhat smooth. The contractile tentacles varied in number with the age of the medusa. Thus, a medusa of 11 mm. diameter had 218 tentacles, the per-radials being 6 mm. long, while another medusa of 12 mm. diameter had about 360 tentacles. Counting the smaller tentacles was difficult. In some of the larger medusæ the arrangement of the tentacles in seven series, as postulated by some European workers, was discernible, while in medium-sized but sexually mature medusæ only four rows could be differentiated. In the smallest medusæ from Horseshoe Lake four per-radial and four inter-radial tentacles were present. These small forms were 0·5–2·5 mm. in diameter. In the mature medusæ very numerous coiled nematocysts with much coiled filaments occurred on the tentacles. Statocysts were embedded in the velum, with their broad bases towards the nettle ring. They were refractile and had short stems. The number of statocysts in the larger medusæ varied, there being roughly about one statocyst to every two or three tentacles. The mature medusæ were all females, the

gonads appearing as elongate pouches or flaps on the radial canals and containing well-formed ova.

These Canadian *Craspedacusta* have been compared with specimens of *Craspedacusta sowerbii*, which Dr. Dejdar[3] kindly sent us from Prague in exchange for *Limnocnida rhodesiæ*, and with *Craspedacusta sowerbii* (or *rileyi*) given us by colleagues in the United States. Morphologically the Canadian medusæ are like both the European and the American forms, and we are inclined to the view of Dejdar and of some American workers that *C. sowerbii* and *C. rileyi* are either the same organism or are but local varieties thereof. *Craspedacusta sowerbii*, then, would be the correct name and the species name *rileyi* would fall into synonymy. The Canadian freshwater medusa would appear to be *Craspedacusta sowerbii*.

From the literature available, it is found that more than thirty sites of occurrence of *Craspedacusta* have been recorded in the United States since the organism was first definitely described by Hargitt[4] in 1907 from Washington, D.C. Budding of minute medusæ from *Microhydra ryderi* had been previously reported by Potts in 1895. The medusa has been found in rivers, lakes, ponds (natural and artificial), quarry pits, reservoirs, filter beds and aquaria. In Canada the habitats of the medusæ were a natural lake and standing water in a grassy hollow, virtually the condition of a temporary pond.

The Canadian locality at Horseshoe Lake, lat. 46° N., at present appears to be the most northerly record of *Craspedacusta* for the American continent, and between Cantik and Rouse's Point, long. 73·25° E., the most easterly record. The most northerly record for the United States appears to be that of Woodhead[5] for Ann Arbor, Michigan, lat. 42·15° N. and the most southerly one Monroe, Louisiana, lat. 32·03° N., given by Viosca and Burkenroad[6].

Our experience of the behaviour of *Craspedacusta sowerbii* in Canada agrees with those of other workers on the organism. It is noted for its sudden and erratic appearance and disappearance in a locality and for the difficulty of finding the hydroid form. Also, often the medusæ from one locality are all of the same sex. Both the type of freshwater habitat and the time of appearance of the medusæ are variable and, in localities where they were found on one occasion, they have not been found again despite searches extending over several years.

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A Whale Shark Rammed by a Vessel off the Pacific Coast of Western Panama

ON May 30, 1932, a whale shark was caught on the bow of the United Fruit Company's steamer *Talamanca* in lat. 8° 14′ N. and long. 82° 46′ W., in the Pacific near Burica Point on the western boundary of Panama. This information was communicated to the U.S. Hydrographic Office by the second officer of the ship (whose name was not given), and was passed on to me by Admiral W. R. Gherardi, hydrographer. Accompanying the account was a splendid photograph showing a whale shark hung on the stem of the vessel.

In my search for exact data on this occurrence, I was handicapped in not knowing the name of the officer who had made the report. For the search I had only the name of the ship and the date. But after prolonged correspondence with the Hydrographic Office and with the United Fruit Co., I finally located the man who observed the occurrence, the second officer of the *Talamanca*, who had been transferred to another vessel and, on another run, had been far away. However, presently there came to my office in the Museum Mr. Paul R. Jones, to whose courtesy I am indebted for the essential facts of this interesting occurrence.

The steamer was proceeding from Panama to Puerto Armuelles on May 30, 1932. The sea was smooth, and fish and porpoises were feeding at the surface. Other porpoises were tumbling in front of the vessel, while a whale shark was lying at the surface to one side of the vessel. Suddenly, for some unknown reason, the great fish swam directly across the vessel's course and was caught on her bow. Since port was only twenty-five miles away, the vessel did not stop to get rid of the fish. In port the fish was dislodged and Mr. Jones noted that it was spotted like a leopard and that it was between 15 ft. and 18 ft. long. Impaled on the bow, the head and shoulder parts were on the left and the greater portion—about 15 ft. long—swung to the right. Thus caught, and being rather small for a *Rhincodon* (which has been measured up to 45 ft.), the shark did not impede the movement of the vessel as it would have done had it been struck nearer the middle.

In addition to being an interesting and unusual method of capturing a whale shark, Mr. Jones's data established a new faunal locality for *Rhincodon typus*. It has been recorded from Cape San Lucas in Lower California, from Guaymas in the Gulf, from Acapulco on the southern Mexican coast, in Panama Bay, at the Galapagos, and off Callao, Peru. I have elsewhere[1] given the geographical distribution and the history of every known specimen of *Rhincodon* up to December 31, 1934. The region of greatest abundance is in southern Philippine waters, and I assigned the Cape San Lucas region and the waters south of it as a second centre of concentration. This new record adds strength to that suggestion.

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Dipole Moment of Pyridine

PREVIOUS workers have obtained values for the dipole moment of pyridine in benzene varying from 2·11 to 2·26 units. We have measured this moment in six solvents at 20°, using carefully purified pyridine having the following physical constants: density $d_{20}^{4} = 0{\cdot}98272$; b.p. 115·2–115·3°/760 mm.; refractive index $n_{D}^{20} = 1{\cdot}50920$; $P_{E} = 24{\cdot}02$ c.c. The results for the polarization and moment are as follows:

Solvent	Dielectric constant	P_{∞} c.c.	Dipole moment μ
Hexane	1·899	127·7	2·21
Cyclohexane	2·018	126·5	2·20
Carbon tetrachloride	2·234	139·3	2·33
Benzene	2·279	132·6	2·26
Toluene	2·380	131·0	2·25
Carbon disulphide	2·638	117·8	2·10

The polarization in hexane, cyclohexane and carbon tetrachloride was almost independent of concentration and was greatest in the solvent of lowest dielectric constant. These results also show similarity with those for nitrobenzene in hexane ($\mu = 4{\cdot}03$) and carbon disulphide ($\mu = 3{\cdot}70$)[1], although the difference in moments in hexane and carbon disulphide is rather less for pyridine than would be expected from a consideration of the moments of nitrobenzene in the same solvents. This result would be explained if, as is probable, the pyridine molecule is more spherical than that of nitrobenzene. This would be expected from a consideration of the Kerr constants for pyridine and nitrobenzene, which are :

	Temp. °C.	$K \times 10^{12}$	$K_1 \times 10^{12}$	$K_2 \times 10^{12}$
Pyridine	146·3	25·7	4·1	21·6
Nitrobenzene	235·5	146·0	7·0	139·0

where K_1 is the anisotropic constant and K_2 the dipole constant at 760 mm. and 546 $\mu\mu$.

The polarization of pyridine in benzene and toluene was, however, found to decrease considerably with increasing concentration, this indicating a larger degree of dipole association in these two solvents than in hexane, cyclohexane and carbon disulphide. The higher value of the moment of pyridine in benzene and toluene may be due to association of pyridine molecules with the molecules of the solvent.

The high moment of pyridine in carbon tetrachloride is probably due to the formation of a complex in solution. This would be expected, since complex formation has been observed in the case of quinoline and carbon tetrachloride[2].

The work is being extended to quinoline and isoquinoline and the results will be published in detail in due course.

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London, E.1.
Feb. 25.

[1] Müller, *Phys. Z.*, **34**, 659 (1935).
[2] Earp and Glasstone, *J. Chem. Soc.*, 1709 (1935).

Anaphylactic Sensitivity Produced by a Chemical Substance

THE phenomena of anaphylactic supersensitivity has been ascribed hitherto to a specific property of natural albumins, and the facts found so far were always explained by the supposition that albumin played an important part in anaphylactic reactions.

It is true that in some cases the *shock* could be reproduced by substances which are practically free from albumins, but these substances are of unknown constitution and are derived from different micro-organisms, such as pneumococci, *Achorion Quinckeanum*, etc. These natural substances are regarded as carbohydrates.

We have now reproduced the anaphylactic sensitization as well as anaphylactic shock by using a compound of known chemical constitution. It is absolutely free from albuminous substances and melts at 184–185°.

This substance, which corresponds to a full antigen, has the following constitution :

$$CH_3(CH_2)_7{-}CH{=}CH{-}(CH_2)_7{-}CO{-}N(CH_3){-}CH_2{-}CH_2{-}SO_3{-}Na$$

Oleyl-(n)-methyl-taurin.

These facts will be discussed in the paper to appear in the *Helvetica chemica Acta*.

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Zurich.
Jan. 29.

[1] *Presse Médicale*, Dec. 1936.

The Advancement of Science and Society

MEMBERS of the American Association for the Advancement of Science have read with much interest the comments on their resolution on international co-operation of scientists which appeared in NATURE of January 22, p. 150. As gratifying as these comments are, in one respect they differ somewhat from the spirit of the resolution.

Since I wrote the resolution and am suggesting to the Executive Committee that it extend formal invitations for an international conference of representatives of scientific societies to be held in London this coming summer, I should like the privilege of explaining the spirit of the resolution, which I believe represents the present sentiment of a large majority of the members of the American Association. By frank expressions of opinions well in advance of the contemplated conference we shall be able to make progress towards mutual understandings of possible slightly different points of view and thus prepare the way for constructive action at the conference, if it should be held.

The resolution passed by the American Association on December 30 was published in the article in NATURE referred to above.

The preamble to the resolution consists of two distinct parts, the first of which acknowledges the profound effects of science upon society and thereby admits a heavy responsibility of men of science to their fellow men. The second part expresses the pure objectivity of science and states conditions only under which it can flourish permanently. Differing from the 1933 resolution of the American Association and from possible interpretations of the comments in NATURE, this preamble is in no degree political or national. There is in it absolutely no note of criticism of Governments or of social orders, for condemnatory words seldom lead to harmony and co-operation.

The resolution itself also consists of two parts, the first of which pertains only to the American Association. It expresses directly only what has long been a distinct policy of the Association. For example, the Section on Medical Sciences is now organizing the tenth of its symposia, participated in by leading American specialists, on subjects (in this case mental health) of wide public interest and importance. Another section has held important symposia on various aspects of conservation of natural resources, while still another has made plans for five symposia on the general title "Science and Society", of which one has been held.

The second part of the resolution relates entirely to international co-operation of men of science. The invitation to co-operation is not dependent on racial, political or theological qualifications ; it is open to every organization in the world the purposes of which are to spread the benefits of science to all mankind.

This sadly disordered world needs some new objective upon which it can focus its attention, some new course of procedure which it will ardently follow. It is possible that men of science can set up such an objective and gradually work out practicable methods for attaining it. Certainly, of all the conclusions that men hold, those of scientists are most easily verifiable and the methods of scientists are most easily evaluated and standardized. The verifiable nature of much of the work of scientific workers and the relative freedom of their conclusions from emotions and prejudices insures for them from the beginning a considerable amount of common ground. Possibly this common ground can be gradually enlarged until it will form a substantial basis for the general progress of civilization. Is it too much to hope that international problems of health, for example, that have been precipitated by the applications of science should be attacked and solved by scientists? Would not the altruistic spirit exhibited by science meet a compelling response in the general conscience of mankind?

Without anticipating what recommendations the American Association may desire to make respecting the purposes of the proposed conference, and not wishing to do more here than to open the question for preliminary discussions, I suggest three things that might be considered and attempted: (1) The formulation of a set of fundamental scientific principles of an ethical nature on which unanimous agreement of the delegates can be reached. (2) The formulation of the maximum number of inviolable methods of international intercourse and co-operation among scientists on which the delegates can unanimously agree. (3) The planning of the necessary machinery for making effective and enlarging the agreements reached in (1) and (2).

F. R. MOULTON
(Permanent Secretary, American Association for the Advancement of Science).

Smithsonian Institution Building,
Washington, D.C.
Feb. 9.

Points from Foregoing Letters

WHEN scandium (^{46}Sc) is bombarded by fast neutrons, two periods, of 52 hours and 4 hours respectively, are observed. These periods have been previously attributed to the formation of ^{44}Sc and ^{43}Sc. It is shown by W. E. Burcham, M. Goldhaber and R. D. Hill that both periods are due to ^{44}Sc, which nucleus, therefore, exists in two isomeric forms.

C. B. Feldman's letter reports investigations of London–New York short wave radio circuits in which newly developed steerable antennæ are used as direction finders. It is stated that, after darkness has begun to fall on the great circle and during the dark period, wide deviations from the great circle sometimes occur in transmission. They are principally southern deviations and seem to be related to ionosphere storms.

Graphs showing the effect of a longitudinal magnetic field upon the refractive index and the conductivity of an ionized gas, are submitted by Dr. S. S. Banerjee and B. N. Singh. The experimental findings agree with the theoretical values calculated by means of new equations in which the collisional frequency is taken into consideration in order to prevent the refractive index and the conductivity from attaining infinite values.

Some results of an X-ray study of the structure of isoprene, butadiene and chloroprene (from which synthetic rubber is produced) are communicated by Dr. C. J. Birkett Clews. At the temperature of liquid air, butadiene gave a good X-ray diagram with about 35 measurable lines which, however, could not be identified with those of any crystal classes of high symmetry; chloroprene gave diagrams with three lines and two diffuse 'liquid' rings; while the results obtained with isoprene indicated a glassy structure.

A virus which crystallizes in the form of rhombic dodecahedra has been isolated by F. C. Bawden and N. W. Pirie from tomato plants infected with the virus which causes bushy stunt. The crystalline substance is apparently a nucleoprotein with high nucleic acid content. It produces infections (local lesions) in *Nicotiana glutinosa* in dilutions of one part in ten millions, and one part per million gives a visible precipitate with its antiserum.

Diagrams of the chromosome pairs in *Crepis capillaris* are given by Prof. D. Kostoff and N. Arutiunian to show the presence of active (euchromatic) and inert (heterochromatic) regions. The authors believe that many cytogenetic phenomena (such as the 'mutual' translocations in *Crepis*) can be best explained by assuming a conjugation between the inert regions of the non-homologous chromosomes. The inert regions may also play a part in interspecific hybridization.

A communication from the late Prof. H. B. Fantham and Mrs. Fantham (Dr. Annie Porter) records the occurrence of the females and young of the freshwater medusa, *Craspedacusta sowerbii*, in Canada at two localities in Quebec Province. The finding of *C. sowerbii* at Horseshoe Lake, Quebec, lat. 46° N., extends the known range of the medusa almost 4° to the north. A habitat approximating to a temporary pond between Cantik, Quebec and Rouse's Point, New York State, long. 73·25° E., is the most easterly record for North America.

The dipole moment of pyridine in six solvents has been measured by B. A. Middleton and Prof. J. R. Partington, and has been found to vary from 2·10 to 2·33. The results indicate that the pyridine molecule is more spherical than that of nitrobenzene and that in benzene and toluene association with solvent molecules may take place. In carbon tetrachloride a complex is probably formed.

Research Items

Microlithic Industries of India

A LIST of microlithic sites in India compiled by Col. D. H. Gordon in *Man* of February shows that so far as our knowledge extends at the moment, these industries extend from Sind on the west to Orissa on the east, and from Mirzapur in the north to Cuddapah (Madras) in the south. It is unlikely that these industries are all contemporary or even in some cases connected in any way. The Indus valley ribbon flake and large core industry is quite separate, and the thick coarse flakes of Bolari Hill, Kotri, etc. (Sind), are of a type not found elsewhere. The area of Mahadeo Hills and Jubbulpore presents an industry homogeneous in type and material. That covered by the Franks collection in the British Museum, Bundlekund and Baghelkund, almost certainly contains an extension of the same culture. The shelters at Singhanpur and Kabra Pahar in Raigarh State also appear to be associated with an industry very similar in type and material. The central Indian industry displays a wide range of types, including crescents, triangles, trapezes (very rare), crescentic blades, straight blades, disk-scrapers and end-scrapers, worked points, borers and cores. Unworked blades and chips are in abundance in localities that were factory sites. One true arrow-head can be claimed; other points have been found with signs of having been worked to form a tang. Association with rock-shelters containing paintings, none likely to antedate 500 B.C., and with pottery in the floors suggests that in these remote regions a microlithic culture may have persisted into the early centuries of our own era. The Pachmari Plateau (Central Provinces) has in addition to rock shelters three factory sites at Tamia. The industry at Singhanpur is of the same microlithic type, the flakes being scattered on a large area to the north of the village. The stone workers lived on the present village site, which probably has been occupied ever since. In northern Hyderabad, the site at Ellora is notable for its proximity to the famous caves. Microliths from Bombay are scanty, while the Punjab has produced none. The microlithic nature of the industry is attributed to the small size of the stone available and renders equation with Western industries unsafe.

Co-operation of Social Groups

THE co-operation of social groups is the subject of a recent article by Prof. F. C. Bartlett (*Occupational Psychology*, 12, No. 1). Few problems of contemporary social life attract more discussion than those connected with the co-operation of differently organized social groups. The impossibility of any effective social group living its life alone is a matter of daily experience, and yet while the need for co-operation is recognized as a necessity for modern groups, actually little is known of the conditions and circumstances on which such co-operation may depend. Prof. Bartlett suggests a study of smaller social groups than the nation, and makes an experimental beginning by collecting accounts of concrete situations, all within the experience of his subjects and all involving a situation between rival groups, forced by circumstances to consider co-operation and finding it necessary to begin. The subjects of the experiment were asked to assume the correctness of the descriptions and to give reasoned judgments as to whether co-operation would break up or develop. The tentative results showed that an ordinary person could give a considered opinion as to the probable chances of the co-operation failing or succeeding; that there was considerable agreement regarding the primary bases of social concord and discord; and that ideas about the leading conditions of social co-operation and discord may vary from one section to another even of the same general community. The writer hopes that investigators will study social harmony and discord, so that it may be possible to understand and control the conditions.

Spread of Grey Squirrel in Britain

CONTINUING his former work, A. D. Middleton, with the help of B. T. Parsons, has summarized the extension of range of the grey squirrel (*Sciurus carolinensis*) in 1937. In many areas on the margins of its former colonies this introduced squirrel continues to spread (*J. Animal Ecology*, 6, 286; 1937). In its central region in England it has pushed farther afield, mainly in the marginal zone from Lincolnshire to Monmouth. It now occurs on the Somerset side of the Avon near Bristol, has increased near Exeter, and there is a notable westward spread to Ashburton. In Yorkshire, as in Essex, there has been less movement, but the whole of North Yorkshire, with Darlington and South Durham, most of West Yorkshire as far as the Pennines, and parts of East Yorkshire are now occupied. In the Cheshire and North Wales district extension northwards has occurred to near Mold and also into the Wirral. In Scotland little change is reported apart from a slight spread to the east, in the 'kingdom' of Fife. Since the grey squirrel has shown itself to be destructive to woodlands, its further and steady extension of range is a matter of some concern.

Control of the Red Spider Mite

THE Lyth Valley, in southern Westmorland, is the site of a localized damson-growing area. A variety known by the name of the county is the chief kind which has been planted, and it is unfortunately very prone to the attacks of the red spider mite *Oligonychus ulmi*. R. A. Harper Gray and H. E. Brooks have investigated methods of control of the pest by spraying (*J. Roy. Hort. Soc.*, 63, Pt. 2, 77, Feb. 1938). Five winter washes gave less control than summer sprays, but a 10 per cent emulsion of tar oil and petroleum was the most satisfactory of those applied in the dormant period. Successful fluids for summer application were refined white oil emulsion, lime-sulphur, and a 2 per cent petroleum wash. In spite of the increased efficacy of the summer treatment, however, control by the winter emulsion is likely to prove a more practicable means of control, since its application would not compete with other pressing work in summer.

Protein Breakdown in Germinating Sweet Peas

CARBOHYDRATES form the chief food store in the seeds of the sweet-pea (*Lathyrus odoratus*), but proteins also are an important factor. In his investigations into the protein breakdown in sweet-pea seeds, W. E. Isaac has shown that these seeds have a protein content amounting to 29·13 per cent, or 33·6 per cent on a dry weight basis (*Ann. Bot.*, New Series, **2**, No. 5, January 1938). It was found that during the experimental period of ten days germination about one third of the protein content was broken down. During the first two days, breakdown was slow; until the sixth day it was more intense, and thence until the tenth day it continued at a uniform, though reduced, rate. These and other results are discussed with reference to the utilization of the energy released by this breakdown.

Climate of North East Land

FROM an account of the meteorological observations of the Oxford University Expedition to North East Land in 1935–36 by Mr. R. A. Hamilton, which was read before the Royal Meteorological Society on February 16, an impression can be obtained of the climate of that remote Arctic island beyond Spitsbergen, which is about equal in size to Wales and lies in about latitude 80° N. The observations cover the period August 24, 1935–August 12, 1936, which is much longer than any previous period of observation. The author states that arctic tradition credits North East Land with very severe and cold winters and with almost continuous gales of between 40 and 100 miles per hour. Such were not the characteristics of the climate during the period under review, but there is reason for believing that the expedition chanced upon an unusually mild winter. A number of observing stations were set up, one of which, on Mount Toil, was 2,060 feet above mean sea-level. A striking feature of the climate at the main base, near the entrance to Brandy Bay, was the concentration of winds into two opposing directions, south-east and north-west, and there was evidence that this peculiarity was shared by an extensive area including most of the Bay. Temperature at all stations was liable to the sudden changes so common in many parts of the Arctic, in winter and spring, variations of about 30° F. in one day being observed. A big fall of pressure generally brought strong winds or gales from south-east and a rise of temperature, followed by a big fall of temperature with increasing pressure and a north-west wind. At the main base the extreme range of temperature was from − 26° F. on an occasion in March to 52° F. in June and 51° F. late in August, and the high-level stations on the permanent ice cap on West Ice, although much colder, especially in summer, showed nothing below − 26° F. Temperatures above 15° F. were recorded in every month. All through the summer, with very few breaks, the ice-cap was shrouded by mist, which generally began at about a height of 300 ft. on the hills around the base. The observations definitely disproved the tradition of continual violent gales; some months in the winter half of the year, indeed, passed without any gales.

Hydrides of Boron

THE structure of B_3H_8 has been represented by Wiberg as $H^+(H_2B{=}BH_2)H^+$ and this 'acidic' representation has been supported by the formation of a supposed diammoniate, $B_3H_8.2NH_3$. H. I. Schlesinger and A. B. Burg (*J. Amer. Chem. Soc.*, **60**, 290; 1938), who found that by interaction of this compound with sodium in liquid ammonia only one equivalent of hydrogen was liberated per mol of diborane, forming a stable salt NaB_3H_8N, and that on allowing the temperature to rise more hydrogen is evolved, but never more than 1·4 equivalents, now describe experiments in which it is shown that borine trimethylamine does not react with sodium. They propose to regard the so-called diammoniate as a mono-ammonium salt in which an atom of nitrogen is interposed in the boron chain, B—N—B. The evidence is indirect. The production of one equivalent of hydrogen by reaction with sodium is explained by assuming the composition $NH_4{}^+[H_3B.NH_2.BH_3]^-$. The slow reaction with further evolution of hydrogen is explained if ammonia removes a BH_3 group by a reversible reaction with production of $NH_4BH_2NH_2$. This is supported by the reaction of $(CH_3)_3N$ with $B_3H_8.2NH_3$ to give borine trimethylamine. The reaction of the new compound $(CH_3)_3OBH_3$ with ammonia and sodium produces the salt $NaBH_3NH_2$, which strongly absorbs B_2H_6; this justifies the assumption that the negative ion of the above structure is easily formed by addition of BH_3 to $BH_3NH_2^-$ and is capable of stable existence. The new compound B_3H_7N, having the skeleton B—N—B, is easily prepared from $B_3H_8.2NH_3$.

Crystal Chemistry

A VALUABLE review of progress made in the crystal chemistry of non-metallic inorganic substances during the years 1927–36 by F. Machatschki appears in *Die Naturwissenschaften* (**26**, 67, 86; 1938). The review deals first with elements, and then with compounds, particularly silicates, borates and complex compounds. There are plentiful references to the literature.

The Lightning Discharge

B. F. J. SCHONLAND (*Proc. Roy. Soc.*, A, **164**, 132; 1938) has now given some conclusions on the mechanism of the lightning flash, resulting from his study of the flash by moving-image cameras. The discharge, in all the cases observed, makes the cloud a cathode, and the first discharge advances in a series of steps. It seems certain that a hitherto unobserved pilot streamer moves downwards comparatively slowly into virgin air, and that a bright streamer follows it with higher velocity, pausing whenever it catches up with the head of the pilot. This leader stroke lowers into the channel an appreciable part of the thundercloud charge, and it is followed by a positive streamer moving upwards along the same channel and neutralizing the charge in it. Subsequent strokes involve a fast 'dart' streamer advancing downwards along the ionized channel and followed by return strokes. Evidence is given that successive strokes involve separate charge-generating centres in the cloud. The mechanism of streamer advance is discussed. Where a previous supply of electrons exists, the mechanism of impact ionization leads to velocities of advance of the order observed for the dart and return streamers, assuming reasonable values for the electron fields at the tip of the advancing discharge. It seems probable that the same mechanism can also explain the slower advance of the pilot streamer into virgin air.

John Hunter as a Pioneer of Veterinary Science

THE annual oration of the Royal College of Surgeons commemorating the life and work of John Hunter, was delivered at the Mansion House on February 28, by Sir Frederick Hobday, emeritus professor of surgery, and formerly principal and dean at the Royal Veterinary College. This made a departure from the usual tradition that a member of the medical profession delivers the address.

Sir Frederick Hobday in his introduction remarked that he felt it appropriate that a member of the veterinary profession should be honoured by the invitation to deliver the oration, for John Hunter was one of the founders of the Royal Veterinary College in 1791. He is described as being "the life and soul of the undertaking", and with him were associated Sir John Banks, Sir George Baker, the Duke of Northumberland and certain members of the Odiham Agricultural Society, who collected the necessary funds, and they were instrumental in bringing to England Prof. Charles Vial St. Bel, of the Veterinary School at Lyons, to be the first principal of the London Veterinary College. The early and unexpected death of St. Bel caused much anxiety regarding the future of the College, and Hunter helped to tide over the emergency.

Sir Frederick Hobday then proceeded to review John Hunter's contributions to veterinary science. One of the first operations performed by St. Bel in Great Britain was the removal of accessory feet that grew from the fetlocks of the two fore-legs of a horse, and it is stated that Hunter personally assisted (he was surgeon at St. George's Hospital) and gave St. Bel "some useful and friendly hints". John Hunter was a genuine lover of horses, and has left some excellent advice upon their management and on the proper way to shoe colts in order to correct defects in the manner in which they may use their fore-legs. His observations on what is termed 'roaring' are of particular interest, and although he did not correctly recognize its cause (paralysis of the left laryngeal nerve), he clearly distinguished this condition from 'broken wind'. Hunter wrote, too, "upon the effects that medicines have upon horses", and was untiring in his studies of the anatomy and physiology of animals—from the mouse to the elephant—birds, reptiles, insects and fishes. The illustrations in his book entitled "Certain Parts of the Animal Economy" cannot be surpassed for clearness and accuracy even with the aids that are now available. His chapter on the glands between the rectum and bladder, the vesiculæ seminales, describes minutely the comparative anatomy and uses of these glands both in man and in numerous animals, and the alterations that ensue after an animal has been unsexed.

The body temperature of animals was another subject to which John Hunter devoted considerable attention. He performed an experiment in which he froze the edge of the comb of a cockerel and remarks that "when I cut off a little bit it did not bleed nor did the animal show any signs of pain"—pioneer work in the use of a freezing mixture as an anæsthetic.

Hunter's writings on digestion bear witness to his keen powers of observation, for he concluded that something secreted in the coat of the stomach acts upon the food and assimilates this to the nature of the blood. He had learnt that it is not possible to make a horse vomit, and recognized the different actions that medicinal agents have upon different species of animals. In regard to the last-named, Sir Frederick remarked that this could have been only through direct observation. Thus, morphine is a narcotic for man and the dog tribe, but produces disastrous delirium in the horse and cat; strychnine and mercurials are much more toxic for the cow and dog than for the horse.

In the realm of surgery, John Hunter's classical experiment of grafting a cock's spur into its comb is well known—definite pioneer work of the various grafting operations that are performed to-day. He also made a series of observations on the reunion of divided tendons.

In conclusion, Sir Frederick Hobday alluded to the importance to a country of its agriculture, its animals and arable products, and of comparative medicine in the fight against disease, for it is here that the medical man and the veterinary surgeon meet on common ground.

Crystal Structures of the Proteins

An X-ray Study of Palmer's Lactoglobulin

By Dr. Dorothy Crowfoot and Dennis Riley, Department of Mineralogy, Oxford

THE crystallization of a lactoglobulin from the albumin fraction of cow's milk by Palmer in 1934[1] was notable both for the size and stability of the protein crystals and for their occurrence in two different crystallographic modifications. The stable tabular form occurs alone when salt solutions of the protein are dialysed at an initial *p*H of 5·8 followed by adjustment to a *p*H of 5·2 with dilute HCl, whilst direct dialysis at a *p*H of 5·2 against distilled water produces needles which may later recrystallize in the tabular form. We have been able to study the inter-relationship of these two varieties through the kindness of Dr. R. A. Kekwick of the Lister Institute, who gave us preparations of them both.

The X-ray measurements show that the two types of lactoglobulin crystals differ not only in crystal structure but also probably in their water content. The tabular crystals are evidently, even on superficial examination, heavily hydrated. They occur commonly either as plates {001} up to 0·3 mm. across and bounded by pyramid faces or as prisms elongated along [010] and showing (100) dominating. They prove to be orthorhombic but are very markedly pseudo-tetragonal, and appear isotropic when viewed along the *c* axis. The birefringence is negative, about 0·004. When these crystals are removed from their

mother liquor they shrink visibly in the direction of the c axis, and the birefringence falls to less than 0·001. This shrinkage is accurately determined by the X-ray measurements which were carried out both on the air-dried crystals and on crystals mounted in their mother liquor. For the wet crystals $a = b = 63·5$ A., $c = 145$ A.; for the dry crystals $a = b = 59$ A., $c = 105$ A. The space group in the case of the wet crystals is $P2_12_12_1$, showing, in X-ray intensities as in dimensions, a close approach to the tetragonal space group $P4_12_1$, whence there are probably 8 molecules in the unit cell. There were too few X-ray reflections from the dry crystals to indicate the space group, but it seems most probable that this unit cell also contains eight molecules, but without water of crystallization.

		Pepsin	Hæmoglobin	Chymotrypsin	Lactoglobulin tabular	Lactoglobulin needle	Insulin	Tobacco seed globulin
Wet	a	116	109	½ × 99	63·5	63·5		
	b	67	63·2	67·8	63·5	63·5		
	Layer-spacing	9 × 51·2	50·2	65	2 × 72·5	2 × 62·5		
	Molecular volume (A.³)	67,000	174,000	55,000	73,000	63,000		
Dry	a		102	45	59	54	130	2 × 61
	b		56	62·5	59	54	74·7	2 × 61
	Layer-spacing		35	53·5	2 × 52·5	2 × 62·5	30·6	2 × 61
	Molecular volume (A.³)		101,000	38,000	46,000	46,000	50,000	455,000
	Shrinkage per cent		42	31	37	27		

The wet needle crystals occupy a place intermediate between the wet and dry tabular crystals. They appear to be exactly tetragonal, elongated along c. The cell dimensions are $a = b = 63·5$ A., $c = 125$ A., space group $P4_12_1$. The fact that the needles show positive birefringence suggests that they differ from the tabular form in the orientation of the molecules as well as in water content, and this is confirmed by the drying phenomena. There is little apparent change in shape or birefringence on exposure of the needles to air, but the very weak X-ray diffraction effects obtained from the dried crystals indicate a new unit cell with approximately $a = b = 54$ A., and $c = 125$ A.

The unit cell dimensions of the different lactoglobulin crystals suggest that in each case there are eight protein molecules in the cell, associated with different quantities of water of crystallization. Some difficulty was experienced, however, in making measurements of the crystal density to check this, owing to the great solubility of the protein crystals in salt solutions. A value of 1·257 was obtained in sugar solutions for the density of the wet tabular crystals, and this may be regarded as an upper limit for the density (*cf.* Adair and Adair[3]). It is in agreement with the presence of a considerable proportion of water in the crystals. It has so far proved impossible to measure the density of the needle crystals in any solvent, since even in sugar solutions the crystals rapidly imbibe liquid, with resultant swelling and loss of shape. The density of the dry tabular crystals in *o*-dichlorbenzene and toluene was found to be 1·27, which is lower than might be expected, probably owing to the occlusion of air in the irregular structure formed in the drying process. The molecular weight of the protein if calculated from this value and the cell dimensions given above is 35,300, or assuming the more probable density of 1·31 (that of dried insulin) 36,500. These values are in agreement with that obtained by ultracentrifuge measurements—about 39,000[2], within the limits of experimental accuracy.

It is of most interest to compare the crystal structure of these protein crystals with those previously measured, pepsin and insulin, and with hæmoglobin and chymotrypsin (recorded below). The similarity in cell dimensions extends also to the types of photographs obtained from wet and dry crystals of lactoglobulin. The wet tabular crystals give very beautiful X-ray pictures with reflections covering the whole field and extending out to spacings of less than 2·4 A. Those from the needle crystals are less good owing to their much smaller size. But with the dry crystals the photographs are very poor indeed, and this is evidently due to the poor orientation of the protein molecules in the collapsed structure. There are no X-ray reflections with spacings less than 20 A. The sharpness of the limit is reminiscent of that already observed on the much better X-ray photographs obtained from air-dried insulin[4], and suggests that in the insulin crystals also a certain degree of molecular disorientation prevails. As might be expected the crystal structure of dry insulin is of a very compact type, while in the wet lactoglobulin crystals, as in pepsin, the molecular arrangement must be loose and extended.

MOLECULAR WEIGHT OF A TOBACCO SEED GLOBULIN

By Dr. Dorothy Crowfoot, Dept. of Mineralogy, Oxford, and Dr. I. Fankuchen, Crystallographic Laboratory, Cambridge

In order to determine the structure of protein crystals from X-ray diffraction effects it is usually necessary to measure fairly large single crystals. An exception to this rule is the case of crystals belonging to the cubic system, for which powder photographs should provide sufficient data. A preparation of a cubic tobacco seed globulin isolated by H. S. Vickery of the Rockefeller Institute, New York, was given to us by Dr. D. M. Wrinch, and this we have examined by the X-ray method in the form of the dry powder.* The crystals were very small but well-formed isotropic octahedra.

Three powder lines were recorded on the X-ray photographs which correspond in spacing to the first three reflections from a cubic face centred lattice of dimensions $a = 123$ A. This value permits us to calculate the maximum molecular weight of the asymmetric unit as 363,000, accepting the presence of only the four molecules in the unit cell required by the symmetry, and the density of $1·287 \pm 0·001$, measured in a sodium phosphate buffer at pH 5·0. Since the crystals lose 10·4 per cent of their weight when dried in a vacuum at 100° due to loss of what may be considered water of crystallization, the maximum molecular weight of the dried protein may be calculated as 325,000. This molecular weight is in agreement in order of magnitude with the sedimentation constant of $12·7 \times 10^{-13}$ found for the same protein by J. Philpot in the Department of

*W. T. Astbury[5] has previously measured the large angle scattering.

Biochemistry, Oxford, and is similar to those of other seed globulins, excelsin and edestin given by Svedberg as about 300,000[6]. The X-ray measurements provide some additional evidence to show that the units present in these proteins are of very considerable size, although at this stage we cannot exclude the possibility that the true chemical molecular weight of the tobacco seed globulin is a sub-multiple of 325,000.

An X-ray Study of Chymotrypsin and Hæmoglobin

By Prof. J. D. Bernal, F.R.S., Dr. I. Fankuchen and Max Perutz, Crystallographic Laboratory, Cambridge

We have recently been fortunate in obtaining well-developed crystals of two proteins—chymotrypsin and hæmoglobin. The former were prepared for us by Dr. Northrop of Princeton and the latter—methæmoglobin of horse—by Dr. Adair at the Physiological Laboratories, Cambridge. In both cases the crystals were well formed and large (½ mm.) and well suited for X-ray analysis.

Chymotrypsin crystallizes in thick diamond-shaped plates at first thought to be orthorhombic but afterwards discovered to be monoclinic twins. It was examined both in the native state in its mother liquor[7] and dried. The cell dimensions are $a = 49{\cdot}6$ A., $b = 67{\cdot}8$ A., $c = 66{\cdot}5$ A., $\beta = 102°$ for the wet crystals, and $a = 45$ A., $b = 62{\cdot}5$ A., $c = 57{\cdot}5$ A., $\beta = 112°$ for the dry. The space group in both cases is probably $P2_1$. The cell volumes are 219,000 and 151,000 A.[3] respectively. It is evident that very considerable shrinkage takes place on drying, nearly all of which is in the direction of the c axis. The density of the wet crystals could be measured by the methods of Adair and was found to be 1·277. If we assumed four molecules per cell this would give a molecular weight including water of crystallization of 42,300. In the case of the dry crystals it was unfortunately impossible to measure the density on account of the difficulty of removing crystallized salts. Assuming the density of the dried protein to be the same as that of dry insulin, namely, 1·31, the molecular weight is 32,000. This value for the molecular weight of a protein seems rather lower than is usually obtained by the centrifuge method, which, however, has not as yet been applied to chymotrypsin. It is difficult without a deeper analysis to say much about the inner structure of the crystals, but the extreme strength of (001) indicates a layer structure, while the weakness of ($h0l$) when h is odd points to a pseudo-glide plane parallel to (010).

The hæmoglobin crystals were found to be monoclinic and usually twinned, corresponding very closely to the description given by Reichert and Brown[8]. The dimensions are $a = 109$ A., $b = 63{\cdot}2$ A., $c = 54{\cdot}2$ A., $\beta = 112°$ for the wet crystals and $a = 102$ A., $b = 56$ A., $c = 49$ A., $\beta = 134°$ for the dry. The space group in both cases is $C2$ with a face-centred pseudo-hexagonal cell. The cell volumes are 348,000 and 202,000 respectively. Here the shrinkage takes place apparently more by the increase of the β angle rather than by the shortening of cell edges. The density of the wet crystals is 1·242, which gives a molecular weight of protein and water on the assumption of two molecules per cell of 131,000. The molecular weight of the dry crystals has not been determined on account of the salt content, but taking the value of 1·26 based on that measured by Chick and Martin[9] for the closely similar serum albumin, the molecular weight is 77,000. The air-dried crystals still contain water. Taking the amount estimated by Haurowitz[10] as 9·6 per cent, the molecular weight of the dry protein becomes 69,000, which agrees excellently with the 67,000 found by chemical methods.

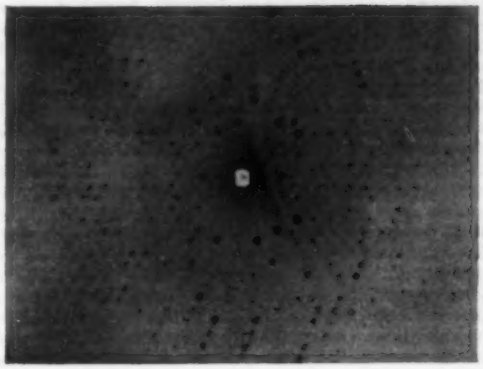

Fig. 1.

Wet hæmoglobin crystal; 5° oscillation about b-axis showing ($hk0$)-zone at centre of photograph. Note the pseudo-hexagonal character of the pattern and the intensity of the reflections at high angles.

The molecular arrangement appears to be based on a layer lattice with a puckered pseudo-hexagonal network. In the dry crystals it is possible to arrive at a structure which accounts qualitatively for the

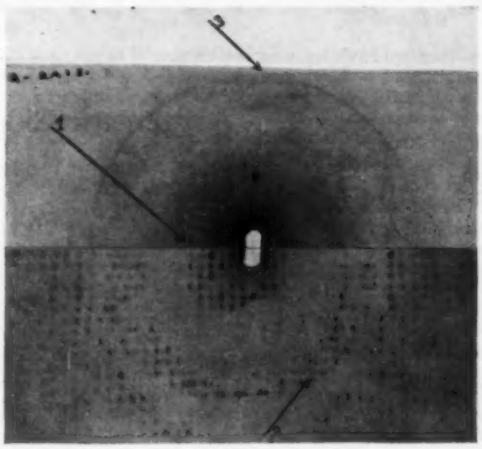

Fig. 2.

Comparison photograph of chymotrypsin: wet below and dry above; 5° oscillation about b-axis showing at centre of photograph the (okl)-zone. Note large difference of spacing of ($00l$)-reflections ($\uparrow_1$) and comparatively small difference of layer-line separation. The wet crystal was a twin; the ($1kl$)-reflections show doubling of spots ($\uparrow_2$). The rapid falling off of intensity in the dry crystal photographs should be noted. There is also the appearance of weak spots at a larger angle, corresponding to a spacing of 5 A. ($\uparrow_3$).

intensities of all the observed planes. In this structure the asymmetric unit is a half molecule of approximate diameter 35 A., linked with three others. The molecule observed in solution may be formed of two of these. The optical properties of the wet crystal point to the approximate parallelism of the hæmatin groups which lie approximately parallel to the (100) planes. As yet their position cannot be inferred, but owing to the two-fold axis of symmetry which the double molecule possesses, only two different kinds of hæmatin globin arrangements are possible. In the meantime, it is possible to draw some useful conclusions from the character of the photographs. In both cases the wet crystals showed perfectly definite reflections at spacings as low as 2 A. This proves the complete internal regularity of the protein molecules down to atomic dimensions. The dry crystals, on the other hand, show in the case of hæmoglobin no reflections of spacing less than 20 A, and for chymotrypsin, except for one or two weak reflections at 5 A., none below 8 A. Dr. Crowfoot had already noticed this phenomenon for insulin and more recently for lactoglobulin. The explanation is probably somewhat as follows. The intensity of a reflection from a protein crystal may be considered a function of three factors: the structure factor due to the position of the molecules, that due to the positions of the atoms inside the molecule, and a third factor depending on the regularity of arrangement. It is apparent that there is a general enhancement of spots in the regions of 9 A. and 4·5 A. corresponding to the two main reflections maxima of denatured proteins. In the dry protein, however, the irregularity is such that only the first of these is retained, the spots corresponding to the outer rim being generally too weak to register. If this analysis is correct, it follows that the change involved on denaturation does not require any considerable movement of atoms or amino-acid residues, but only relatively minor rearrangement together with almost complete loss of regularity, the dry protein representing an intermediate stage.

As can be seen from Fig. 2 the dried crystals of chymotrypsin show not only alterations of spacing but also of relative intensities of reflection. If we assume that drying takes place by the removal of water from between protein molecules, studies of these changes provide an opportunity of separating the effects of inter- and intra-molecular scattering. This may make possible the direct Fourier analysis of the molecular structure once complete sets of reflections are available in different states of hydration.

Already sufficient protein crystals have been examined by X-rays to be able to point to significant regularities. The table of lattice dimensions referred to three axes at right angles shows that the proteins fall into two groups: pseudo-hexagonal and pseudo-cubic, in both cases with a side of 60–75 A. This is of the order of twice the diameter of a protein molecule.

The work already done shows the wealth of new data that can be obtained by X-ray methods from reasonably well-crystallized proteins. The full advantage of the possibilities can, however, only be realized by work on a far larger number of protein types under different physical conditions, together with a more detailed application of crystal analysis.

[1] *J. Biol. Chem.*, **104**, 359 (1934).
[2] *Proc. Roy. Soc.*, B, **120**, 422 (1936).
[3] Pedersen, K. O., *Biochem. J.*, **30**, 961 (1936).
[4] *Proc. Roy. Soc.*, A., **164**, 580 (1938).
[5] *J. Chem. Soc.*, 849 (1935).
[6] *Chem. Rev.*, **20**, 81 (1937).
[7] Bernal, J. D., and Crowfoot, D., NATURE, **133**, 794 (1934).
[8] Reichert and Brown, "The Crystallography of Hemoglobin". Carnegie Inst. of Washington (1909).
[9] Chick and Martin, *Biochem. J.*, **7**, 92 (1913).
[10] Haurowitz, F., *Z. Physiol. Chem.*, **136**, 147.

Asymmetric-Sideband Broadcasting

AT a meeting of the Wireless Section of the Institution of Electrical Engineers on March 2, Mr. P. P. Eckersley read a paper entitled "A Quantitative Study of Asymmetric-Sideband Broadcasting". This paper directed attention to the fact that the progress of radio broadcasting is being hampered by the lack of a sufficient number of channels in which to contain the increasing number of transmissions. In the present state of the art, few, except local, stations can be received without interference from other broadcasting stations on adjacent frequency channels, unless the upper modulation frequencies of the wanted programme are severely attenuated. This inter-station interference can be reduced if all or part of one sideband of the transmitted spectrum is cut away; and it is the object of the asymmetric-sideband system of transmission to cut away part of one sideband without loss of the higher modulation frequencies and without introducing audible harmonic distortion.

Mr. Eckersley then gave a quantitative analysis of the phase and amplitudes of the sideband components and the effect of these factors in producing distortion. Curves have been derived, which show the required attenuation-constant of filters which cut away part of one sideband but produce no more than a constant, small distortion. A description was also given of practical tests in which the quality of reproduction obtainable from an asymmetric transmitter was compared with that given by orthodox modulation. It is claimed that while a highly trained ear may occasionally be able to detect some slight differences between the two types of reproduction when they are directly compared, no difference is detectable with modern broadcast receiving apparatus.

The last part of the paper showed that the asymmetric system has three possible applications to broadcasting as it is practised to-day. First, it could be used to allow carrier frequency differences of 11 or 12 kc./sec. without introducing any sideband overlap interference. Secondly, it could be applied to existing conditions in which the carrier frequencies differ by about 9 kc./sec., and it would then reduce inter-station interference to about one tenth of its present value. Thirdly, if the existing interferences are considered to be tolerable, then the differences between the carrier-frequencies of stations can be reduced to 6 kc./sec., without increasing the interference; this implies that one and a half times the number of stations working in Europe to-day on exclusive wave-length channels could be accommodated in the existing wave-band.

University Events

CAMBRIDGE.—The degree of Sc.D. has been conferred on C. H. Waddington, of Christ's College, lecturer in zoology.

The Faculty Board of Economics and Politics has appointed M. Paul van Zeeland, of Brussels, to be the Alfred Marshall lecturer for the year 1938–39.

The General Board has made the following grants from the income of the Worts Fund: £25 to F. H. Stubbings (of Emmanuel College) towards the expenses of a visit to Ithaca for archæological purposes; £12 to C. G. L. Shankland (Queens' College) towards the expenses of a visit to Italy to study the architecture of that country; £30 to L. H. McCabe (Peterhouse) towards the expenses of an expedition to Iceland to study the geography of that island; £100 to N. E. Odell (Clare College) towards the expenses involved in accompanying the Mount Everest Expedition 1938 for geological and glaciological study; £40 to G. E. Daniel (St. John's College) towards the expenses of a journey in France for the study of certain megalithic monuments in that country; £40 to F. J. Simonds (St. John's College) towards the expenses of a visit to Yugoslavia for a study of the ecology of certain insect larvæ in the streams of that country; £40 to M. Ballinger (St. John's College) towards the expenses of a visit to the Marine Biological Station, Tamaris, South France, to study the metabolism of the electric organ and muscular tissues of the torpedo; £60 to D. M. Carmichael (St. John's College) towards the expenses of an expedition to West Greenland to study the social habits and psychology of the Eskimo.

CAPE TOWN.—Prof. A. W. Falconer, professor of medicine in the University, has been appointed principal and vice-chancellor in succession to Sir Carruthers Beattie, who has retired.

LONDON.—Prof. I. M. Heilbron has been appointed as from October 1 to the University chair of organic chemistry tenable at the Imperial College of Science and Technology. Since 1935 he has been Sir Samuel Hall professor of chemistry and director of the chemical laboratories in the University of Manchester.

Mr. W. J. John has been appointed as from October 1 to the University chair of electrical engineering tenable at Queen Mary College. Since 1936, he has been University reader in electrical engineering at that College.

MANCHESTER.—Dr. Willis Jackson has been appointed Edward Stocks Massey professor of electrotechnics and director of the Electro-Technical Laboratories of the University as from September 29, when the appointment of Prof. Robert Beattie expires. Dr. Jackson is at present research engineer to Metropolitan-Vickers Electrical Co., Ltd.

MELBOURNE.—Dr. J. S. Turner has been appointed professor of botany. Dr. Turner is at present senior demonstrator of botany in the University of Cambridge.

OXFORD.—Dr. J. R. Baker, New College, lecturer in zoology, has been granted the degree of D.Sc. for his work in zoology and biological chemistry.

SHEFFIELD.—Dr. W. H. Pearsall has been appointed professor of botany in succession to Prof. B. H. Bentley, who is retiring at the end of the present session.

Science News a Century Ago

The Copper Mines of Cornwall

AT a meeting of the Statistical Society held on March 19, 1838, Sir Charles Lemon read a paper entitled "An Account of the Origin and Progress of the Copper Mines in Cornwall" in which he dealt with the history of the mines, the adoption of steam pumps and steam winding engines, production, employment, wages, consumption of coal and timber and the health of the workers. Newcomen engines were introduced early in the eighteenth century, but these had all been superseded by the improved engines of Boulton and Watt.

The total amount of coal reported to have been used in 1837 was 1,213,439 bushels, of 84 lb., and the total amount of water pumped by 60 engines was 31,141,800 tons. The production of ore and its value at various intervals between 1771 and 1837 was given as follows:

	Ore (tons)	Copper (tons)	Value of ore in £
1771 ..	27,896	3,347	189,609
1800 ..	55,981	5,187	550,925
1821 ..	98,426	8,514	605,968
1837 ..	140,753	10,823	908,613

The total number of persons employed in 59 mines was 10,624 men, 3,802 women and 3,490 children, and it was calculated that in 1836 about £482,000 was paid in wages. The average wages of a miner was 51*s.* 6*d.* per week.

Flooding of the Thames Tunnel

THE *Annual Register* for 1838 under the date of March 20 gives the following account of an irruption of the river into the Thames Tunnel on that day:

"One gang of labourers had been relieved by another when the water began rushing in with a loud noise. . . . In a few minutes the tunnel was filled. . . . Since the last irruption in Oct. 1837 the excavations had proceeded with more than usual rapidity owing to great increase in the enormous quantity of clay thrown down over the tunnel which formed an artificial bed of great consistency past which the works were advanced 3 ft. making in all 20 ft. added to the tunnel since the break-in six months before. At the beginning of the week the soil became loose, a vein of sand was encountered and it was found necessary to proceed with more than ordinary caution. On the night before the irruption the ground presented some indication of giving way, and much difficulty was experienced in going on with the excavations, the entrance of the sand and water being only prevented by the intrepidity of some of the old miners. Every precaution was consequently taken to prevent the loss of life which has sometimes attended the breaking-in of the river and the previous indication of danger, and the formation of the double gangways, enabled the workmen to get away without losing one of their number. Immediate measures were taken to stop up the aperture, which was soon ascertained to be of no very great dimensions. Several large loads of clay were thrown down immediately above the spot; and the shore engine employed to pump the water from the tunnel, which by the end of the month was completely cleared so as to allow of the works being resumed."

A New Tide Gauge

AT a meeting of the Royal Society held on March 22, 1838, Mr. T. G. Bunt gave a description of a new tide gauge constructed by himself, and erected on the eastern bank of the River Avon, in front of the Hotwells House, Bristol. In this apparatus a float was connected by a wire to a wheel and drum, 1/18 of the vertical motion of the float being given to a bar carrying a pencil which recorded the rise and fall of the water on a paper on a cylinder driven by an eight-day clock.

Dublin Zoological Society

"THIS institution," said the *Mechanics' Magazine* of March 24, 1838, "has in some degree overcome the difficulties whose occurrence seemed to threaten its very existence a short time ago. Extraordinary means, however, are obliged to be resorted to, in order to make up the deficiency of funds under which it labours. Among these is a series of lectures on Natural History delivered gratuitously by some of the most eminent physicians of the Irish capital, under the patronage of the Lord Lieutenant. It would be a pity indeed, if 'the second city in the Empire' should, like too many of our large provincial towns, suffer its Zoological Gardens to fall into decay after a short season of flattering success."

New Professorships in Paris

THE *Athenæum* of March 24, 1838, stated that "Dr. Duvernoy, of Strasbourg, at which place he holds a high situation in the university, has been appointed to the new professorship at the Collège de France, named the 'Natural History of Organised Bodies'. M. Poncelet, of the Academy of Sciences, has also been elected to the new chair of Physical and Experimental Mechanics, belonging to the Faculty of Sciences, and which has been created in consequence of the increasing manufactures and industry in France. A third chair has been instituted at the Jardin des Plantes, viz., that of Comparative Physiology, which has been given to the Chevalier Cuvier. To this list may be added the election of M. Audouin, the entomologist to the Academy of Sciences".

James Lowe's Screw Propeller

Two years after John Ericsson and Francis Pettit Smith patented their screw propellers, James Lowe (1798–1866) took out patent No. 7599 of March 24, 1838 for improvements in propelling vessels "by means of one or more curved blades set or fixed on a revolving shaft below the water line of the vessel". His propeller was tried in H.M.S. *Wizard* and afterwards in H.M.S. *Rattler* and H.M.S. *Phœnix*. In 1844 he brought an action against Penns of Greenwich for infringement, and the evidence showed that although Lowe was not the original inventor of screw propellers he was the first to use the combination of a segment of a screw, and of a segment applied to an axis below the water and with the segment totally submersed. Lowe, who was born May 13, 1798, was an apprentice of Edward Shorter, the London inventor of "the perpetual sculling machine", and became a merchant and smoke jack maker. He met his death by being run over by a wagon on October 12, 1866. He is buried in the churchyard at Ewell, Surrey.

Societies and Academies

Dublin

Royal Irish Academy, January 24.

B. N. SINGH: Cytoplasmic bodies in the oogenesis of the vulture (*Neophron percnopterus gingivianus*), with special reference to the effect of ultra-centrifuging on the oocytes of the pigeon. After ultra-centrifuging, the cytoplasmic bodies in the oocytes of the pigeon are stratified as follows: fat and cholesterol at the centripetal end; next, a layer of Golgi bodies, followed by a layer of mitochondrial yolk, and the mitochondria which are the heaviest components in the cell and occupy the extreme centrifugal end. No relationship exists between sudanophil fat and the Golgi bodies. Cholesterol bodies filter in from the egg membranes to the oocytes in the pigeon. No pre-existing 'vacuome' could be seen.

R. W. DITCHBURN: Diffraction by irregular gratings. The properties of gratings in which the spaces between the lines and the intensity scattered by a given line are not constants are discussed. It is shown that general expressions of a fairly simple type can be given for the diffraction functions but that it is difficult to apply these general expressions in the design of gratings. By computation and trial and error it is, however, possible to design gratings which have interesting and useful properties. In particular, it is possible to increase the resolving power considerably by the omission of some of the rulings of an ordinary grating. Examples of the application of the theory to line and echelon gratings are given.

ARCHIE LAMONT: Contemporaneous slumping and other problems at Bray Series, Ordovician, and Lower Carboniferous horizons in County Dublin. Accounts are given of submarine sliding of sediments. These appear to have been a surface expression of deep-seated tectonic adjustments. The Ordovician slumping corresponds with a horizon close to the transition between Caradocian and Ashgillian, and evidence of movement of a fault at this juncture is adduced. Carboniferous landslides, apparently set off by seismic agencies, were intensified during the Nassauian and Sudetic phases of mountain-building on the Continent. Anti-dune structures produced by anomalous marine currents are described.

J. SELWYN TURNER contributes a revision of the Carboniferous stratigraphy of the district.

Paris

Academy of Sciences, January 17 (*C.R.*, 206, 137–220).

EMILE BOREL: The laws of the probable evolution of finite ensembles of segments.

HENRI COLIN: Affinity and specific chemism in grafted *Helianthus*.

GABRIEL BERTRAND: An unexpected intervention of the manure industry in reducing the fertility of soils. It has been shown that boron is an essential element for certain crops. Potash from Alsace contains boron, but the purification of the crude sylvinite, while raising the percentage of potassium substantially, reduces the proportion of boron, with a possibly prejudicial effect on the crops.

FRANÇOIS GRANDJEAN: The ontogeny of the Acarians.

HYACINTHE VINCENT: Experimental typhoid infection by the method of protected inoculations.

GUSTAVE MALÉCOT: The analysis of chances and the problem of heredity.

H. ADAD: Circles paratactic to two given circles and surfaces several times encircled.

ANDRÉ LICHNEROWICZ : The singularities of the exterior ds^2.

GUSTAVE CHOQUET : Study of plane homeomorphies.

RENÉ HIRSCH : The stabilization of aeroplanes.

LÉOPOLD ESCANDE : Flow through a submerged valve gate.

HENRI MINEUR : The dynamical equilibrium of galactic clouds.

JUNIOR GAUZIT : The spectrum of the Finsler comet in the visible region. Outline of results obtained at the Lyons Observatory, with a criticism of the conclusions drawn by R. Minkowski regarding the presence of the red spectrum of cyanogen in the Finsler comet.

JEAN XANTHAKIS : The variation of azimuth of the line of the meridional sights of the Strasbourg Observatory.

LOUIS ROUTIN : An improvement in the applications of the gramophone to teaching.

EMILE PIERRET : The electronic oscillations of triode valves. Experiments showing that triode valves with unsupported spiral grid can give rise to electronic oscillations of well-defined frequency.

CHARLES HAENNY : Photographs of multiple rays in the subsoil.

MAURICE REY, HENRI HERBIET and PIERRE COHEUR : The influence of cobalt salts on the anodic behaviour of lead in a sulphated electrolyte.

MLLE. YVETTE CAUCHOIS and HORIA HULUBEI : Non-characteristic white and dark lines in the spectra of X-rays obtained by crystalline diffraction.

ROGER ARNOULT : The continuous β-spectrum of thorium-B.

MARIE LOUISE DELWAULLE, FÉLIX FRANÇOIS and JOSEPH WIEMANN : The application of the Raman effect to the study of the constitution of solutions of zinc iodide and cadmium iodide.

P. BELLAIR : The origin of the Pelvoux granite.

ANDRE WAHL, MARTINUS GOEDKOOP and EDOUARD HEBERLEIN : α- and β-naphthoylacetic esters.

ARNOLD BERSIER : The character and meaning of the sedimentation in the alpine pre-fosse (external phase).

MARIUS DALLONI : Intrusion of the Cenomanian on the primary axial zone of the Ariegeois Pyrenees.

GEORGES CHOUBERT : The Dogger of the eastern Haut-Atlas.

ANDRÉ MEYENDORFF : The primary series of Gourara.

GÉRALD ANDREW and JEAN CUVILLIER : The discovery of the marine Oligocene in the region of Borg el-Arab.

PIERRE DANGEARD : A new *Cystoseira* from the Cap Vert Peninsula, *C. senegalensis*, and on some other African *Cystoseira*.

JEAN FLECKINGER : The size of the flowers and pilosity of the calyx in relation to polyploidy in the apple tree.

LÉON ACOLAT : Comparative study of the blood pressure in the pulmonary circuit and in the general circuit in Batrachians and reptiles.

A. JULLIEN and D. VINCENT : The action of acetylcholine on the heart of molluscs. The curare-acetylcholine antagonism.

HENRY SCHWAB : The opposed effect of small and large doses of aluminium salts in hypoglycæmia due to insulin and hyperglycæmia due to adrenalin.

GABRIEL FLORENCE and MME. ANDRÉE DRILHON : The absorption in the ultra-violet of blood ultra-filtrate.

EMILE ROUSSEAU : Differential reaction between blood or urine of cancerous and normal subjects.

MICHEL FLANZY and MARCEL BANOS : The presence of secondary propyl alcohol in alcohol from wine. Secondary propyl alcohol appears to be a normal constituent of alcohol from wine.

Moscow

Academy of Sciences (*C.R.*, 17, No. 6, 1937).

S. BERNSTEIN : Some modifications of the inequality of Tchebysheff.

M. KRAVČUK : Some approximations in the problem of moments for the functions with two variables.

B. LEWITAN : (1) A new generalization of quasi-periodic functions. (2) Linear differential equations with quasi-periodic coefficients.

N. KOTCHIN : A particular case of Riemann's problem.

I. VÉCOUA : General representation of solutions of equations with partial derivatives of the second order.

N. MOISSEIEV : Problem of the localization of dynamic trajectories in the space of phases.

L. LANDAU : Origin of stellar energy.

N. WASSMUTH : Contributions to the theory of Brownian movement.

G. L. SHNIRMAN : An elementary theory of the spring suspension of the vertical seismograph.

M. K. TIKHONOV : Corrosion of iron at the boundary : metal-liquid-gas and metal-liquid-liquid.

N. A. DZIUBAN : Nutrition of some Cyclopidæ (Crustacea).

I. A. FILIPPENKO, E. H. GERBER and O. K. ELPIDINA : Photosynthesis as applied to citrous plants in natural conditions.

I. A. FILIPPENKO : Formation of bios in the vernalized embryos of winter wheat.

C.R., 17, No. 7, 1937.

N. CUDAKOV : Problem of Goldbach.

W. LIUKSHIN : Bending of rotation surfaces with negative curvature and a single point.

I. PETROVSKIJ : Systems of differential equations all solutions of which are analytical.

J. G. METSCHWARISCHWILI : Limit solutions of differential equations of hyperbolic type with variable coefficients, in the case of two independent variables.

W. W. SHOULEJKIN : Theory of monsoons. (3) The importance of the size and shape of continents and seas.

A. E. OSTROVSKIJ : Measurements of the rate of propagation of elastic vibrations on small bases.

N. N. VOROŽCOV, A. P. ALEXANDROV and T. I. BERKOVA : A new product of reaction between anthraquinone and alkali.

E. V. ZMAČINSKIJ and L. I. MALIŠEVSKAJA : New method for obtaining benzil from benzoin.

M. M. KACNELSON and M. S. KONDAKOVA : Investigations on normal acids with a long chain, which is closed by a cyclohexyl or a cyclopentyl.

L. L. IVANOV : A chemico-microscopic study of a meteorite from the Yurtuk village, Dnepropetrovsk region, which fell on April 2, 1936.

I. SEDLECKIJ : Genesis of minerals from soil colloids of the group of montmorilonite.

N. A. ILJIN : Parallel variability in phenogenesis of the ear shell in Canidae.

O. G. ALEXANDROVA : Anatomy of various types of wheat grain.

V. G. ALEXANDROV : Morphology of the grain of cereals.

A. A. VOITKEVIČ : Morphogenetic activity of different parts of the hypophysis. (9) On the gonadotropic action of the substance from the "basophile zone" of the anterior lobes of the hypophysis.

Forthcoming Events

[Meeting marked with an asterisk is open to the public.]

Monday, March 21

ROYAL GEOGRAPHICAL SOCIETY, at 8.30.—J. M. Wordie: "An Expedition to Baffin Bay and Arctic Canada in 1937".

Tuesday, March 22

EUGENICS SOCIETY (in the rooms of the Royal Society, Burlington House, Piccadilly, W.1), at 5.15.—Miss Evelyn Fox: "Modern Developments in Mental Welfare Work".*

BIRKBECK COLLEGE, PHYSICAL SOCIETY, at 6.—E. G. Dymond: "Cosmic Rays in the Arctic" (Distinguished Visitor's Address).

Thursday, March 24

ROYAL SOCIETY, at 2.30.—Discussion on "The Application of Quantitative Methods to Certain Problems in Psychology".

Appointments Vacant

APPLICATIONS are invited for the following appointments, on or before the dates mentioned:

TEACHER OF CHEMISTRY in the Northern Polytechnic, Holloway, London, N.7—The Clerk (March 23).

ASSISTANTS (grade III—radio engineering) at the Bawdsey Research Station, Woodbridge, Suffolk—The Secretary, Royal Engineer and Signals Board, Regent's Park Barracks, Albany Street, N.W.1 (March 25).

HEAD OF THE CHEMISTRY DEPARTMENT of the Coventry Technical College—The Director of Education, Council House, Coventry (March 26).

INSPECTOR FOR LIVESTOCK in the Department of Agriculture for Scotland—The Secretary (Establishment Branch), 29 St. Andrew Square, Edinburgh, 2 (March 26).

LECTURER IN GARDENING, BIOLOGY AND ELEMENTARY SCIENCE in the Caerleon Training College—The Higher Education Department, County Hall, Newport, Mon. (March 28).

ASSISTANT ADVISER IN MYCOLOGY at the Long Ashton Research Station—The Registrar, University of Bristol (April 2).

ASSISTANT LECTURER AND DEMONSTRATOR IN DIETETICS AND PHYSIOLOGY in the King's College of Household and Social Science, Campden Hill Road, London, W.8 (April 11).

ANALYTIC CHEMIST in the Medical Department of the Gold Coast and GOVERNMENT ANALYST in Mauritius—The Director of Recruitment (Colonial Service), 8 Buckingham Gate, London, S.W.1 (April 15).

ASSISTANT KEEPER IN ENTOMOLOGY in the Manchester Museum, University of Manchester—The Registrar (April 20).

LECTURER IN PHYSICS in University College, Hull—The Registrar (April 23).

LECTURER IN PHYSICS AND LECTURER IN MATHEMATICS in King's College, Newcastle-upon-Tyne—The Secretary to the Council (April 30).

DIRECTOR OF THE NATIONAL INSTITUTE OF AGRICULTURAL BOTANY—The Chairman of the Council, N.I.A.B., Huntingdon Road, Cambridge (May 9).

UNIVERSITY LECTURER IN GEOLOGY in the University of Cambridge—Secretary of Appointments Committee, Department of Mineralogy and Petrology, Cambridge (April 19).

RESEARCH ASSISTANT in the Oxford University Observatory—The Savilian Professor of Astronomy.

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